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BULLETIN
of the
American Association *of* Petroleum Geologists

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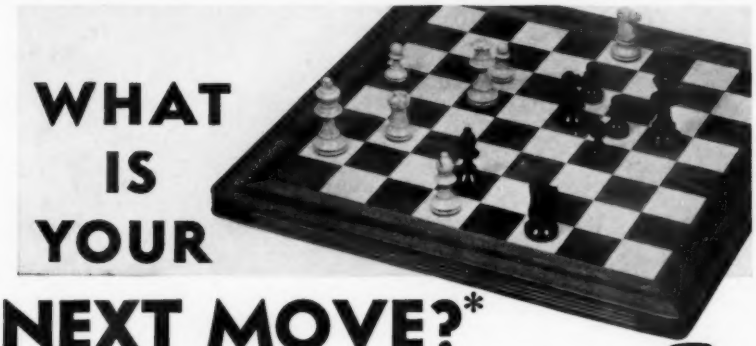

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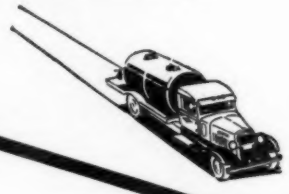

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Volume 21 Number 8

BULLETIN
of the
AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

AUGUST, 1937

DISCOVERIES IN CALIFORNIA IN 1936[1]

M. G. EDWARDS[2]
South Pasadena, California

ABSTRACT

Discoveries of supplies of oil and gas in California during 1936 exceeded those of any previous year since 1931. Excluding deep-zone developments, which were an important source of new supply in 1931, discoveries of fields in 1936 exceeded in importance those of any year since 1928, the year in which the Kettleman Hills-North Dome and Elwood fields were discovered. Five new oil fields, two new gas fields, and a number of extensions to known fields are credited to the year 1936. The first oil-field discoveries in California by geophysical methods occurred in this year.

INTRODUCTION

Following a 4-year period, 1932–1935, during which discoveries were relatively unimportant from the standpoint of future oil reserves, the year 1936 was a fairly successful year. It is probable that the fields discovered during the past year will exceed in oil reserves those of any year since 1928, the year in which the North Dome-Kettleman Hills and Elwood fields were discovered. The year was also marked by the first oil-field discoveries made in California by reflection survey, but geologic mapping, micropaleontology, and structural interpretation by other subsurface methods continue to be of constant and effective use. Search for extensions of old fields or of new deep zones in proved fields also met with considerable success in many of the oil-producing areas throughout the state. It is significant that most of the important discoveries of the past year were in Miocene rather than in Pliocene oil zones.

LOS ANGELES COUNTY

WILMINGTON FIELD

The General Petroleum Corporation is responsible for the most important discovery in the Los Angeles Basin in 1936 with the com-

[1] Read before the Association at Los Angeles, March 18, 1937. Manuscript received, May 3, 1937. Published by permission of E. F. Davis, vice-president, Shell Oil Company.

[2] Geologist, Shell Oil Company.

pletion of its Terminal well No. 1, located a short distance west of Long Beach in the Wilmington Harbor district. This well was completed on December 6, flowing in excess of 1,600 barrels per day of 20.5° gravity oil. The oil is produced from a 600-foot Upper Miocene oil zone known as the "Terminal zone," the top of which was encountered not far below 3,100 feet. Prior to completion from this zone,

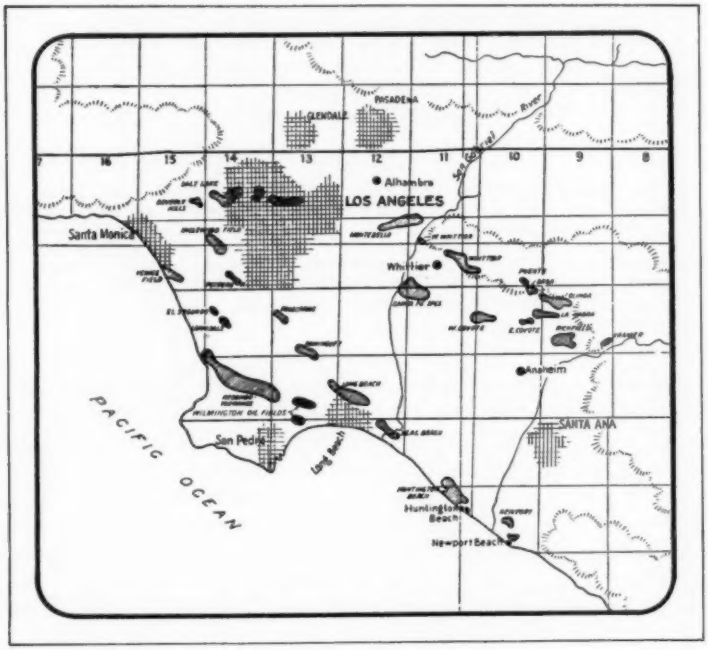

FIG. 1.—Los Angeles Basin, showing locations of oil fields.

three other zones had been tested—two higher and one lower. All of these zones produced oil, estimates ranging from 100 to 200 barrels per day. The Wilmington structure is anticlinal, with some complication by faulting.

The completion of Terminal No. 1 stimulated a great amount of activity in the Wilmington district, particularly in the town-lot area of Wilmington north and northwest of the discovery well, and this field has continued to be the most active field in California from the standpoint of projects under way.

EL SEGUNDO FIELD

The El Segundo field is located near the coast, midway between the Torrance-Redondo and Venice fields. Original discovery in this area was made in September, 1935, with the completion of Republic Petroleum Company-El Segundo well No. 1 for about 250 barrels per day of 28° gravity oil. This was followed by two other small completions and it was not until December, 1936, that the Richfield Oil Company completed the first big well in the field, El Segundo No. 1, for 2,400 barrels per day of 27.2° gravity oil from the interval 7,323–7,435 feet. Production is coming from the Upper Miocene basal conglomerate, which rests directly on Franciscan schist, the same member which is productive in the Playa del Rey field. Both major and independent operators are active in the development of this field.

NORTH REDONDO

A small area at the northwest edge of the Torrance-Redondo field passed through a period of activity by independent operators following the completion of the Dumas-Lewis well No. 1 in March, 1936, with an initial production in excess of 400 barrels per day from an oil zone near the Pliocene-Miocene contact. Most of the completions were for 50–200 barrels per day. Activity in this area has now subsided.

DEEP ZONE DEVELOPMENTS

Exploration for new deep zones in the Los Angeles Basin is now under way in the Richfield, Santa Fe Springs, Dominguez, and Rosecrans[3] fields. During the past year the Union Oil Company opened up the Eighth Callender zone in the Dominguez field, and still deeper exploration is scheduled for 1937.

VENTURA COUNTY

PADRE CANYON FIELD

Surface and subsurface mapping are responsible for the discovery of the Padre Canyon field, the first of the new fields to be discovered in 1936. This field lies about 6 miles northwest of the town of Ventura and slightly north of the Ventura-Rincon anticlinal trend.

The discovery well, Continental Oil Company-Hobson No. 1, was completed in February, 1936, with an initial production of approximately 600 barrels per day of 29.5° gravity oil and 300,000 cubic feet of gas, with the bottom of the well at 5,501 feet. Production comes

[3] Barnsdall-O'Dea No. 10, the deep test of the Rosecrans field, was completed in March, 1937, from a depth of 7,540 feet in an Upper Miocene oil zone hitherto unexploited in this field. Present production (April, 1937) is between 700 and 750 barrels per day of 35.8° gravity oil.

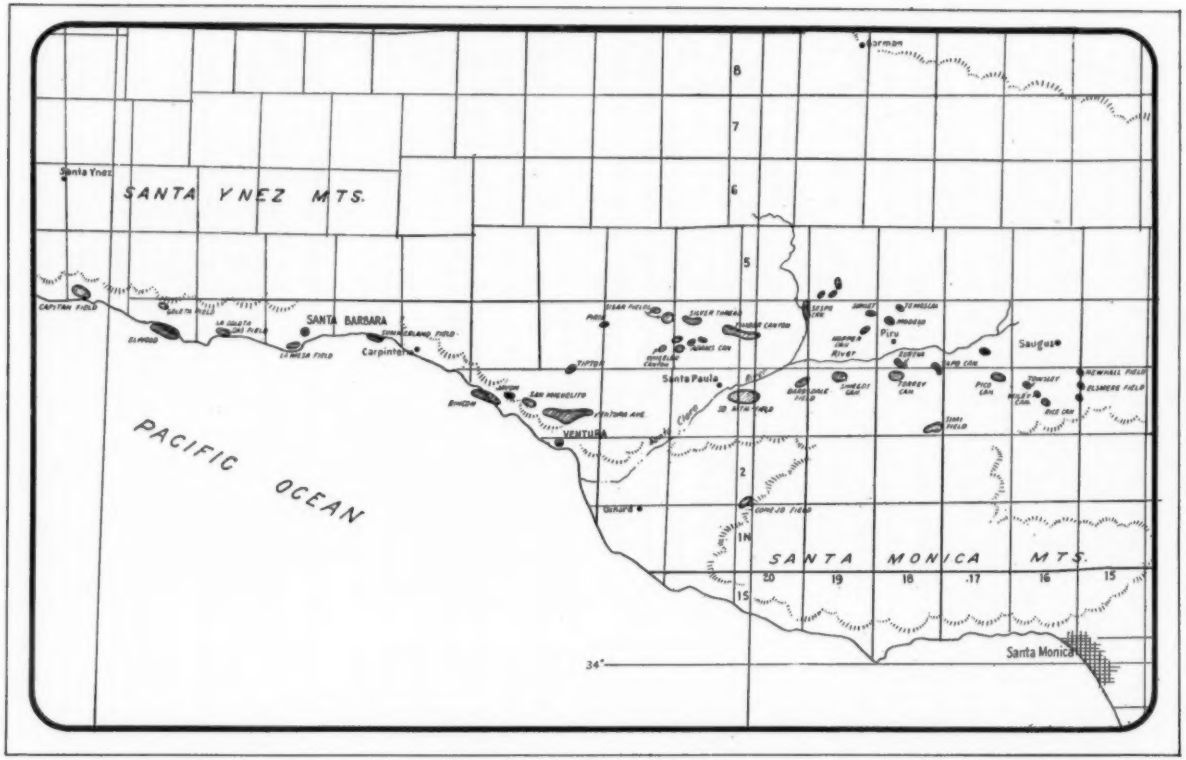

FIG. 2.—Showing locations of oil fields in Ventura County and Santa Barbara County coastal region.

from an Upper Pliocene oil zone. The area is one of complex structure, and oil accumulation is generally believed to have been caused by a fault trap. The General Petroleum Corporation and C.C.M.O. are sharing in the development of this area.

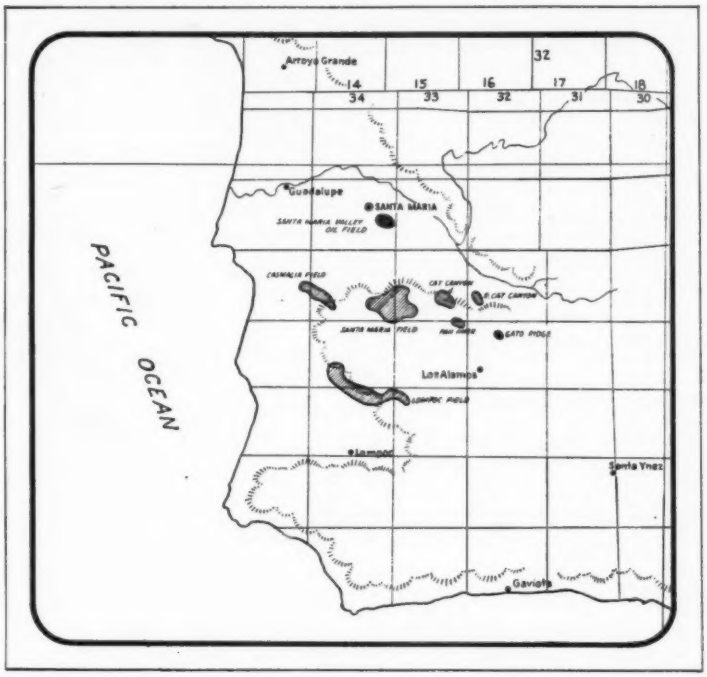

FIG. 3.—Santa Maria district, northern Santa Barbara County.

BARDSDALE DISTRICT

Eocene production was obtained in the Bardsdale district in August, 1936, when the Union Oil Company-Dryden well No. 10 was completed on the pump from the interval 5,260–6,561 feet for approximately 100 barrels per day of 32.6° gravity oil.

SANTA BARBARA COUNTY

SANTA MARIA VALLEY FIELD

First production in the Santa Maria Valley field, southeast of the town of Santa Maria, was obtained in 1934 when the Union Oil Company completed two small wells of less than 50 barrels each, but

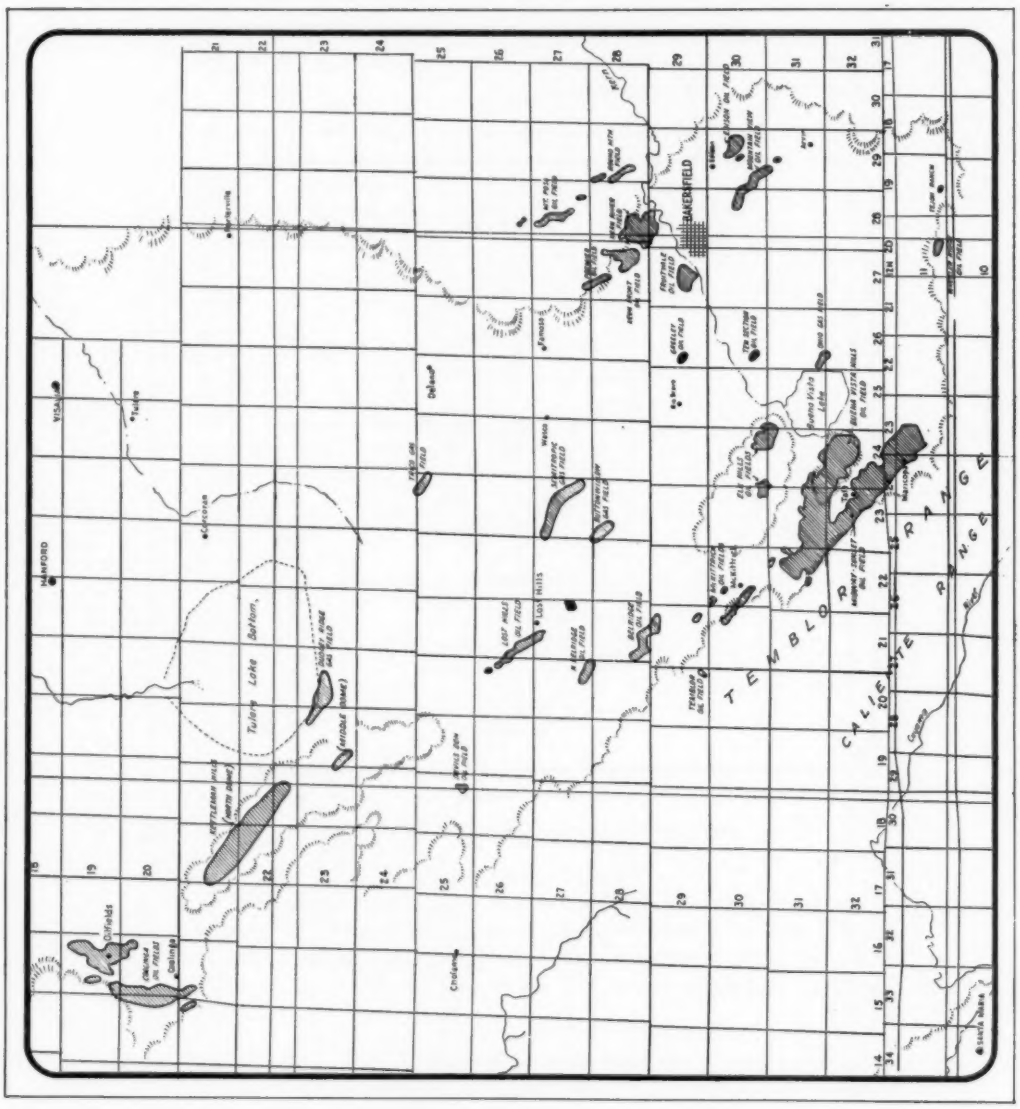

FIG. 4.—Southern San Joaquin Valley, showing locations of oil fields.

the field became one of major importance with the completion of the Union Oil Company-Adam well No. 1 in March, 1936. Initial production was 2,376 barrels per day of 16.4° gravity oil from a depth of 2,576 feet. The oil zone is of Monterey (Miocene) age, and accumulation is due to stratigraphic closure formed by overlap of Pliocene beds, with fault complications present in a portion of the area which has subsequently proved productive. Discovery was the result of a subsurface study from core holes and regional geology.

SAN JOAQUIN VALLEY

TEN SECTION FIELD

The Ten Section field was discovered early in June, 1936, with the completion of the Shell Oil Company-KCL well No. 1 flowing 850 barrels per day of 61° gravity oil and 14,000,000 cubic feet of gas. The producing zone was in the 76-foot interval between 7,812 and 7,888 feet. Later wells of about 35° gravity oil were completed in the lower and middle portions of the oil zone, which has a thickness of approximately 600 feet.

The Ten Section discovery is generally regarded as the year's most important find, in that it demonstrated commercial production from a new deep zone of Upper Miocene age never before exploited on the floor of the San Joaquin Valley. Geophysical prospecting, which was active before this discovery, was considerably increased throughout this portion of the valley, and a number of deep tests were begun soon thereafter.

GREELEY FIELD

In December, 1936, the Standard Oil Company was rewarded with discovery in KCL well No. 11-1, located approximately 7 miles north of the Ten Section field in what is now known as the Greeley field. The Standard well started flowing at the rate of 2,600 barrels per day of 37° gravity oil and about 2,000,000 cubic feet of gas from the interval 7,742–7,807 feet. The limits of the Ten Section and Greeley fields have not yet been defined by drilling, and it is still too early to give any estimate of their probable importance from the standpoint of future reserves. The age of the producing horizon in the Greeley field is believed to be practically the same as that of the Ten Section field, but whether or not they are exact stratigraphic equivalents is difficult to determine, because of lateral variation in lithology, absence of diagnostic fossil markers, and lack of a sufficient number of intervening wells. Several wells are now drilling at widely separated points in southern San Joaquin Valley, with this horizon as the

FIG. 4.—Southern San Joaquin Valley, showing locations of oil fields.

objective. The year 1937 will furnish a part of the answer regarding this particular phase of California exploration, but the degree of success can not yet be predicted.

Several extensions of old producing areas and new spots of local accumulation within producing areas were discovered during the year on both the east and the west sides of San Joaquin Valley.

The Gibson Oil Company developed a restricted area of production north of Maricopa Flats, which initiated considerable drilling

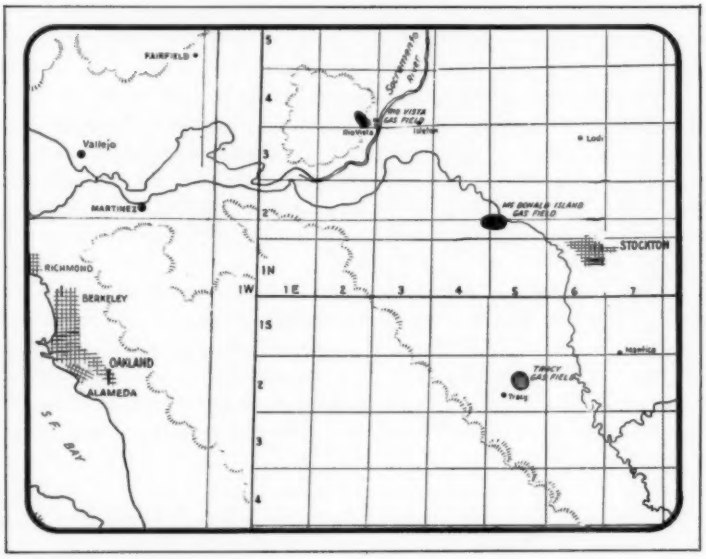

FIG. 5.—Map showing locations of McDonald Island, Rio Vista, and Tracy gas fields.

activity and several good completions followed, but the area of substantial production was small. Mohawk Petroleum Company-Earl Fruit No. 1 opened a new area southeast of the Mountain View field, with production from Upper Miocene sands lying directly on the granitic basement. The Associated Oil Company completed several shallow producers in a northern extension of the Lost Hills field. Several good producers were completed in the deep Wagonwheel zone of the North Belridge field, Kern County, from depths of about 8,500 feet. The Reserve Oil Company is continuing active exploration of Tejon Ranch, 5 miles east of Wheeler Ridge, with good prospects of opening a new area of production. Recent activity has been

centered in an area 2½ miles northwest of the site of the Reserve-Tejon well No. 1, which was completed in June, 1935, with an initial daily production of 45 barrels per day of 16° gravity oil.

GAS FIELDS

Two new dry gas fields were discovered by reflection survey methods during 1936, about 50 miles northeast of San Francisco. The Standard Oil Company completed its McDonald Island well No. 1 in June, flowing approximately 27,000,000 cubic feet per day of gas from a depth of 5,227 feet. The producing zone is of Eocene age. The McDonald Island gas field lies about 10 miles west-northwest of Stockton, in San Joaquin County.

The Rio Vista gas field, located just west of Rio Vista in Solano County, was discovered by the Amerada Petroleum Corporation when its Emigh well No. 1 was completed for approximately 9,000,000 cubic feet of gas per day, from a depth of 4,485 feet, with production from Eocene strata. The Rio Vista gas field is located 18 miles northwest of the McDonald Island field.

Exploration in California is more active at the present time than it has been for several years past, and there is no indication of a decrease in this activity during the coming year.

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VOL. 21, NO. 8 (AUGUST, 1937), PP. 986-999, 4 FIGS.

DEVELOPMENTS IN ROCKY MOUNTAIN REGION IN 1936[1]

A. E. BRAINERD[2] AND CHARLES S. LAVINGTON[3]
Denver, Colorado

ABSTRACT

Discovery of two oil-producing horizons at 3,085 and 5,014 feet, respectively, in the fresh-water Wasatch (Eocene) beds by The Ohio Oil Company on the Powder Wash anticline in Moffat County, Colorado, is the outstanding development of 1936. This discovery opens a vast new area for prospecting in northwestern Colorado and southwestern Wyoming.

Cores from two deep tests in Wyoming on the Muskrat anticline in Fremont County, and on the Gooseberry anticline in Park County, indicate the possibility of two new black-oil fields in the Embar-Permian and Tensleep (Pennsylvanian).

Discovery of oil in the Mosser dome in Yellowstone County, Montana, is of interest, although of questionable commercial importance.

Deeper drilling on the Cedar Creek anticline of the Baker-Glendive gas area in eastern Montana has resulted in the discovery of black oil in the Madison (Mississippian) limestone at 6,820 feet and in the Devonian(?) at 8,050 feet. This well is less than ¼ mile from the North Dakota line on a narrow fold more than 100 miles in length, which extends through Dawson, Wibaux, and Fallon counties, Montana, and Bowman County, North Dakota.

Much geophysical prospecting for structure was conducted throughout the region, and test wells so located in Goshen County, Wyoming, in Grant County, Nebraska, and in Washington and Yuma counties, Colorado, encountered basement rocks at much shallower depths than expected.

Routine developments in the several fields, especially at Lance Creek, which was the "hot spot" of Wyoming, and new outlets for crude in the way of new pipe lines, have materially increased the production of the region.

INTRODUCTION[4]

The most important development in the Rocky Mountain region during 1936 was the discovery of commercial light oil in the Wasatch (Eocene) of northwestern Colorado. The Wasatch formation which is of fluviatile origin[5] has not heretofore been considered seriously for oil production although oil-saturated sandstones and gas seeps at various places have long been known. This discovery opens a vast area for prospecting in northwestern Colorado and southwestern Wyoming.

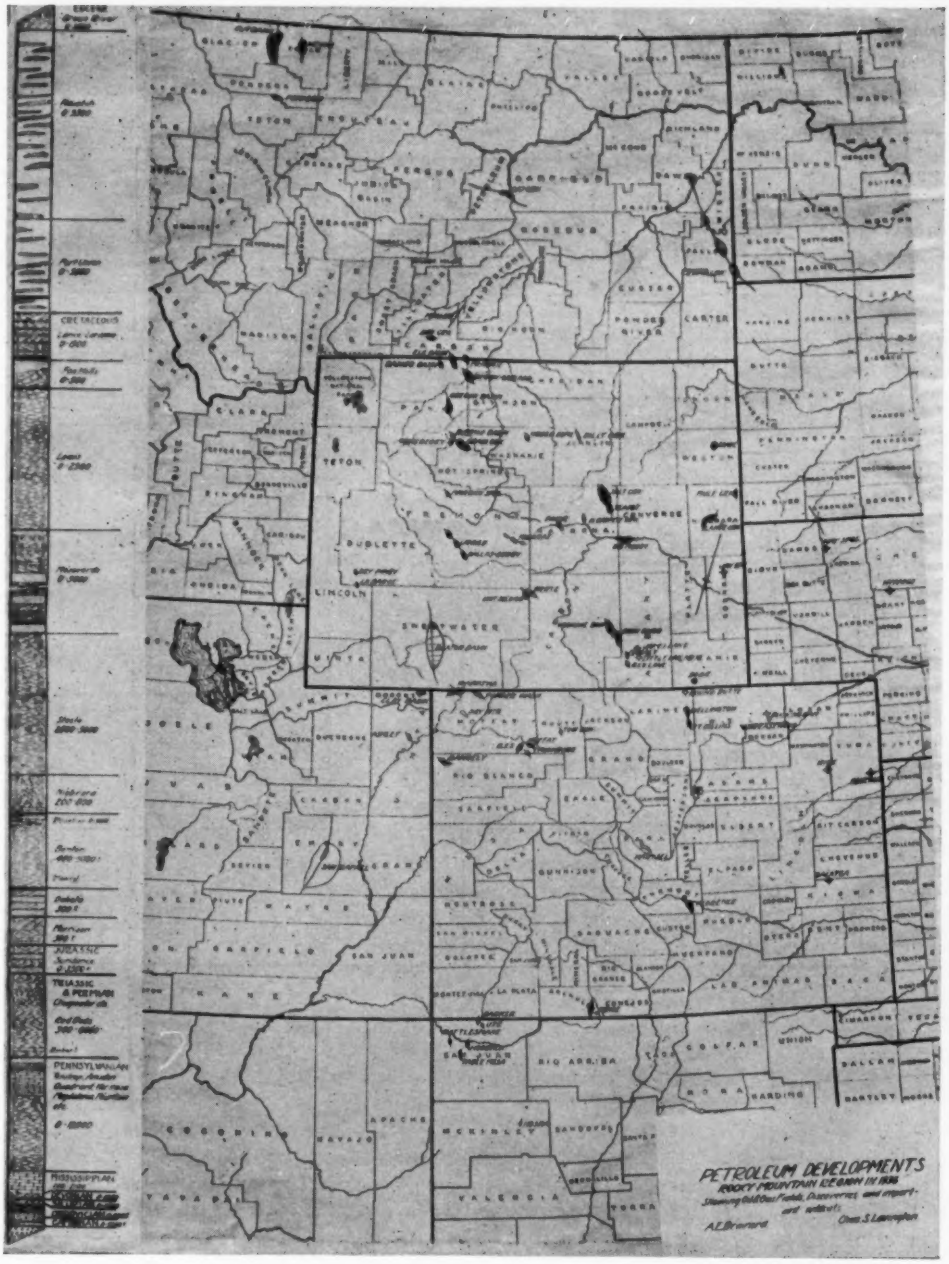
[1] Read before the Association at Los Angeles, March 18, 1937, with the permission of Continental Oil Company. Manuscript received, July 2, 1937.

[2] Division Geologist, Continental Oil Company, Denver, Colorado.

[3] Geologist, Continental Oil Company, Denver, Colorado.

[4] The writers wish to express their thanks to Earl Shoenfelt of Petroleum Information, Inc., for many of the data herein contained.

[5] J. D. Sears and W. H. Bradley, "Relations of the Wasatch and Green River Formations in Northwestern Colorado and Southern Wyoming with Notes on Oil in the Green River Formation," *U. S. Geol. Survey Prof. Paper 132-F* (November, 1924).


PETROLEUM DEVELOPMENTS
ROCKY MOUNTAIN REGION IN 1936
A.E. Brainard
Chas. S. Lewellen
TETON
LINCOLN
SWEETWATER
SAN JUAN
GARFIELD
MESA
MONTROSE
GUNNISON
OURAY
SAGUACHE
CHAFFEE
EAGLE
PITKIN
GARFIELD
RIO BLANCO
MOFFAT
ROUTT
JACKSON
LARIMER
WELD
PHILLIPS
SEDGWICK
LOGAN
MORGAN
WASHINGTON
YUMA
KIT CARSON
CHEYENNE
KIOWA
BENT
PROWERS
BACA
LAS ANIMAS
HUERFANO
CUSTER
FREMONT
OTERO
CROWLEY
EL PASO
TELLER
PARK
CLEAR CREEK
GILPIN
BOULDER
GRAND
JACKSON
LARIMER
WELD
ADAMS
ARAPAHOE
DOUGLAS
ELBERT
LINCOLN
KIOWA
CHEYENNE
KIT CARSON
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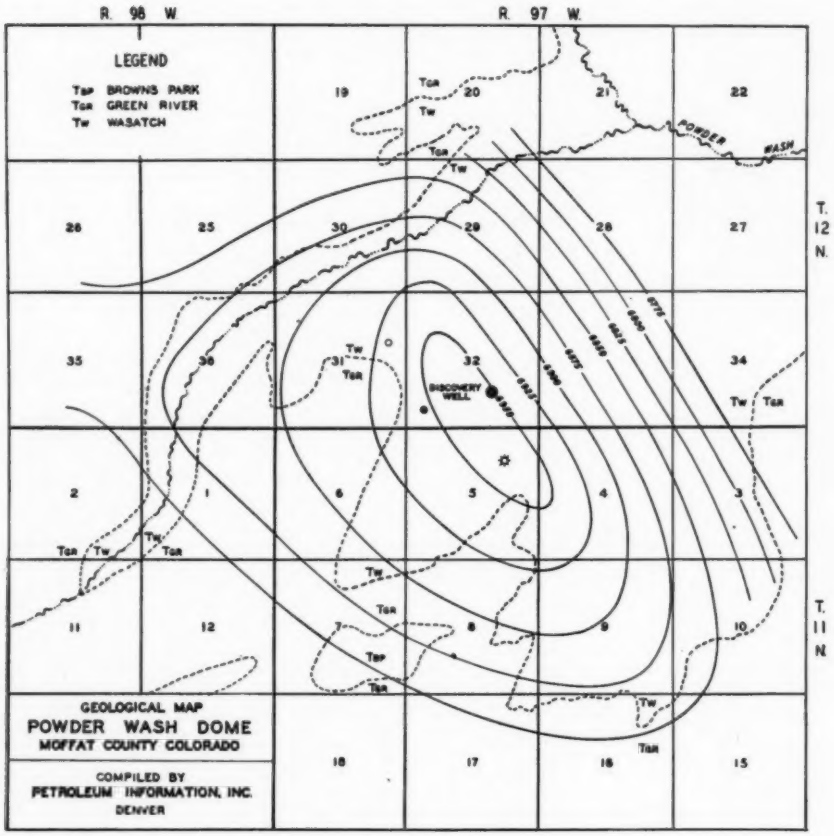
R. 98 W.
R. 97 W.
LEGEND
Tbp BROWNS PARK
Tgr GREEN RIVER
Tw WASATCH
POWDER WASH
DISCOVERY WELL
T. 12 N.
T. 11 N.
GEOLOGICAL MAP
POWDER WASH DOME
MOFFAT COUNTY COLORADO
COMPILED BY
PETROLEUM INFORMATION, INC.
DENVER

FIG. 2

DISCOVERIES

All the discoveries during 1936 have been due to deeper drilling in old fields or on structures formerly tested to shallower horizons, with the exception of that on the Hartsel anticline, which is of doubtful commercial importance.

COLORADO

Powder Wash.—The Mountain Fuel Supply Company, drilling on a previously proved gas structure, the Powder Wash anticline, in T. 12 N., R. 97 W., Moffat County, Colorado, opened two new oil horizons at 3,085 and 5,014 feet, respectively.

The upper of the two sandstones tested 1,000 barrels per day and the lower, which is near the base of the Wasatch formation, tested 1,100 barrels of 39.9° A. P. I. green oil. The Powder Wash anticline, which is a low fold between the Washakie and Sand Wash basins, has a closure of about 100 feet and an area of about 5,000 acres.

Hartsel.—The South Park Oil Company encountered oil in the Pierre shale (Cretaceous) adjacent to an igneous sill at 4,158 feet on the Hartsel anticline in Ts. 11 and 12 S., R. 75 W., Park County, Colorado. The well flowed 75 barrels of 36.5° A. P. I. oil in 18 hours, was shut in for want of tankage, and when subsequently opened failed to flow again. A second well, which started much lower in section, recently (1937) found oil in the Pierre shale at about the same depth. Both may make small pumpers.

The Hartsel anticline is a long, narrow, curved fold plunging northwest, in front of a large overthrust fault. Surface beds are Laramie, Fox Hills, and Pierre shale (Cretaceous).

Thornburg.—On the Thornburg structure in T. 3 N., R. 91 W., Moffat County, Colorado, the Continental Oil Company in deepening an old gas well encountered 2½ million feet of gas in the "Sundance" at 2,550 feet. Gas was discovered in the Dakota in 1925 and the field was shut in until 1936. There are two other gas wells on the structure, which has about 1,000 feet of closure and 550 acres proved for gas. One other well on the flank of the anticline, and lower structurally, had a showing of oil in the Sundance.

MONTANA

Mosser.—Roy C. Tarrant, of Sheridan, Wyoming, drilling on the Mosser anticline in T. 3 S., R. 24 E., Yellowstone County, Montana, opened a new oil pool in the Cloverly (Dakota) sandstone at 1,008 feet. The well is rated at 100 barrels. The surface formation is the Colorado shale (Cretaceous) and the structure is in the Fromberg fault zone. It has a closure of several hundred feet against the fault.

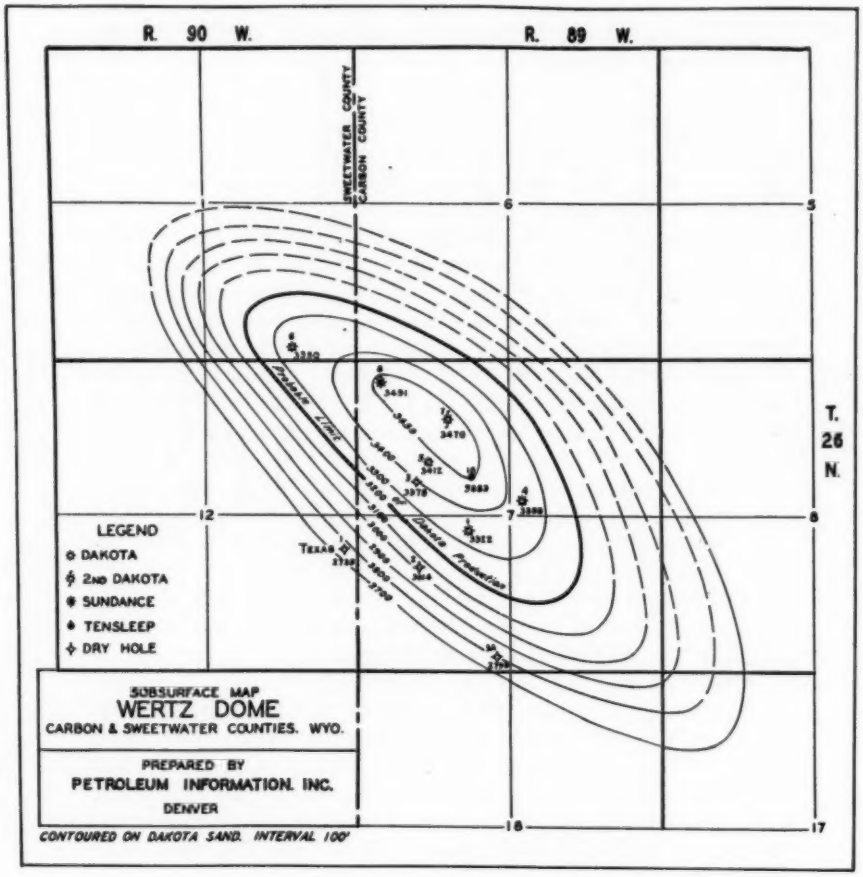
R. 90 W.
R. 89 W.
SWEETWATER COUNTY
CARBON COUNTY
T. 26 N.
6
5
12
7
8
18
17
Dakota Limit
Dakota Production
LEGEND
DAKOTA
2ND DAKOTA
SUNDANCE
TENSLEEP
DRY HOLE
SUBSURFACE MAP
WERTZ DOME
CARBON & SWEETWATER COUNTIES. WYO.
PREPARED BY
PETROLEUM INFORMATION. INC.
DENVER
CONTOURED ON DAKOTA SAND. INTERVAL 100'

FIG. 3

This discovery, although of interest, is of doubtful commercial importance as it will probably be of very limited extent.

Little Beaver.—On the Little Beaver dome of the Cedar Creek anticline in T. 4 N., R. 62 W., Fallon County, Montana, the Montana-Dakota Utilities Company found heavy black oil in the Madison (Mississippian) and Devonian (?) at 6,747 and 8,186 feet, respectively. The former tested 125 barrels and the latter tested 200. This discovery is on the anticline better known as Baker-Glendive, which is more than 100 miles long and extends through Dawson, Wibaux, and Fallon counties, Montana, and into Bowman County, North Dakota. This structure has produced gas from the Judith River (Cretaceous) for many years. The Little Beaver dome, of which the surface formation is Pierre shale, has a local closure of about 250 feet. This discovery is of considerable interest in that it encourages exploration of these horizons in the adjoining states.

WYOMING

In Wyoming, wells on the two "near" discoveries, Muskrat and Gooseberry, have not been completed (June, 1937) and their commercial importance is not yet known.

Muskrat.—On the Muskrat anticline in T. 33 N., R. 92 W., Fremont County, Wyoming, the Sinclair-Wyoming Oil Company has found good black-oil saturation in the Embar (Permian) at 7,268–7,293 feet. This is one of several "highs" on a long anticline. It has 500 feet of local closure. There is one old gas well on the structure which produces from the Frontier.

Gooseberry.—The General Petroleum Corporation on the Gooseberry anticline in T. 47 N., R. 100 W., Park County, Wyoming, found good black-oil saturation in the Embar (Permian) at 5,660 feet. This is on a large fold with two "highs" which had two unsuccessful wells drilled previously to shallower horizons. Steele shale is the surface formation and there is about 700 feet of local closure.

Wertz.—Sinclair-Wyoming Oil Company found commercial production in the Tensleep sandstone (Pennsylvanian) in the Wertz dome in T. 26 N., R. 89 W., at 5,869–5,883 feet. Unlike the Tensleep oil of northern Wyoming, this is light oil of 32° gravity, and contains much less sulphur. The well tested 2,000 barrels per day. This discovery is in an old Cretaceous gas field on a structure of about 1,500 feet of closure. The surface formation is lower Steele or upper Niobrara (Cretaceous).

AREAS OF PRINCIPAL DEVELOPMENT

MONTANA

Cut Bank.—On a basis of number of wells completed, the Cut Bank field in Ts. 32 to 35 N., Rs. 5 and 6 W., Glacier County, Montana,

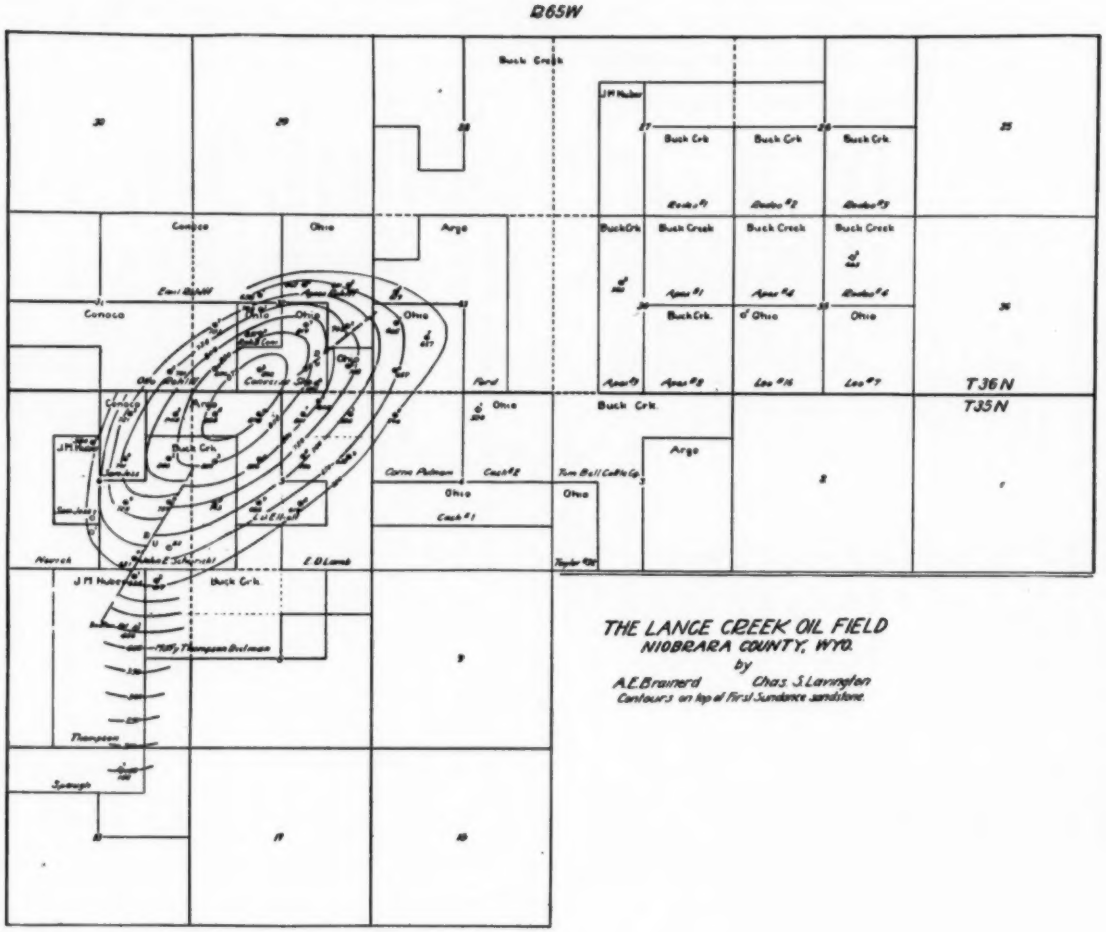
R65W
Buck Creek
Conoco
Ohio
Argo
Buck Crk.
Buck Creek
T36N
T35N
THE LANCE CREEK OIL FIELD
NIOBRARA COUNTY, WYO.
by
A.E.Brainerd Chas. S.Lavington
Contours on top of First Sundance sandstone.

FIG. 4

takes the lead in the Rocky Mountain region. There were 122 completions during 1936, 15 of which were dry. The total number of wells was 231. Production from this field comes from a monoclinal wedge of Kootenai (Cretaceous) sandstone at 2,800–3,050 feet on the west flank of the Sweetgrass arch. Wells average about 40 barrels of greenish brown oil of 38° Bé. gravity. The surface formation is Two Medicine (Mesaverde) Cretaceous.

Kevin-Sunburst.—Next in number of wells was the Kevin-Sunburst field in T. 35 N., Rs. 2 and 3 W., Toole County, Montana, with 73 completions, 13 of which were dry holes. The total number of wells was 1,077. This field, which produces from an old erosion surface of Madison limestone at 1,500–1,800 feet, is on a large, low-dip dome in the Benton (Cretaceous) shale. It was discovered in 1922 and was revived by acidizing about 1933. The oil is black and high in sulphur, and wells vary from 3 to 800 barrels initial.

WYOMING

Lance Creek.—The Lance Creek field was the "hot spot" of Wyoming for 1936. There were 19 completions with one dry hole, making a total of 42 producing wells in the Sundance. The field was extended 1½ miles eastward by the Buck Creek Oil Company's Apex No. 2. Production comes from the Sundance (Jurassic) at 3,800–4,000 feet. The oil is 48° gravity and wells vary from 75 to 3,000 barrels initial. Recently a new producing horizon has been opened in the lower Minnelusa (Pennsylvanian) formation at 5,516 feet, which promises to be of greater areal extent than that of the Sundance. This field, which was discovered in 1918, originally produced mainly gas from the Dakota and Muddy (Cretaceous) sandstones. Discovery of oil in the lower Sundance was made by The Ohio Oil Company in 1935. The field is on a long curved anticline and has about 700 feet of closure. The surface formation is Pierre shale (Cretaceous) and White River (Tertiary).

Byron-Garland.—The Byron-Garland field in Ts. 55 and 56 N., Rs. 97 and 98 W., Big Horn County, Wyoming, had 13 completions during 1936. Production comes from the Embar-Tensleep (Pennsylvanian-Permian) at 4,100–5,100 feet. The oil is of a heavy black character and wells range from 50 to 1,600 barrels. There are two large parallel anticlines which are greatly faulted. The surface formation is Cody shale (Cretaceous).

Medicine Bow.—On the Medicine Bow anticline in Ts. 20 and 21 N., R. 79 W., Carbon County, Wyoming, The Ohio Oil Company, and The California Company jointly completed 4 wells during 1936,

making a total of 3 oil and 3 gas wells. The anticline, which has a closure of 1,700 feet or more and a productive area of about 800 acres, produces from the Sundance (Jurassic) at an average depth of 5,500 feet. Wells produce initially 1,900–3,900 barrels of 56.9° gravity oil. The surface formation is basal Mesaverde. Discovery in the Sundance was in 1935.

Rock River.—The Ohio Oil Company completed 10 wells in the Sundance on the Rock River anticline in Ts. 19 and 20 N., R. 78 W., Carbon County, Wyoming. Some of these were deepened from the Dakota series, which was the original producing horizon, and 2 were key wells for repressuring. This anticline, the surface formation of which is Steele shale (Cretaceous), has about 1,500 feet of closure. The depth to the Sundance averages about 3,250 feet and wells produce initially 25–1,000 barrels of 36.6° gravity oil. The field was discovered in 1918 and the first Sundance production was in 1935. The structure has been tested recently to the Tensleep sandstone (Pennsylvanian) with negative results.

Quealy.—The Quealy anticline in T. 17 N., R. 77 W., Albany County, Wyoming, had 5 completions during 1936, with one dry hole, making a total of 5 producers. Oil was discovered by The California Company in the Muddy and Dakota sandstones in 1934, and the Sundance in 1936. Two dry holes had been previously drilled on this fold, which has a closure of about 500 feet. The depth to the Dakota averages about 3,200 feet and the wells begin in the Steele shale.

COLORADO

Price.—On the Price anticline in T. 33 N., R. 2 E., Archuleta County, Colorado, the Hughes Estate completed 2 wells to the Dakota, making a total of 5 producers. This field, which was discovered in 1935, is on a narrow sharp fold in the Mancos shale. The average depth to the Dakota, the producing horizon, is about 1,400 feet and the wells produce from a few barrels to 1,000 barrels of light oil. This field is particularly interesting in that it is almost completely surrounded by extrusive igneous rock. It lies along the narrow valley of the Navajo River.

NEW MEXICO

Rattlesnake.—The Continental Oil Company completed 12 wells, of which 2 were dry holes, on the Rattlesnake anticline in T. 29 N., R. 19 W., San Juan County, New Mexico. This fold, which has the Tocito sandstone of the Mancos (Cretaceous) at the surface, produces from the Dakota series at an average depth of 800 feet. The fold has a closure of 100 feet or more and about 260 acres are productive.

There are now 56 producing wells. The field was discovered in 1923 and the initial production ranged from a few barrels to 1,000 barrels per day. The gravity of the oil averages 64.8°.

Red Mountain area.—In the Red Mountain area in T. 20 N., R. 9 W., McKinley County, New Mexico, there were 10 completions, of which 7 were dry. This is a small fault structure in the Mesaverde (Cretaceous) and small production of 20–25 barrels daily is obtained from the same formation at about 450 feet.

EXTENSIONS TO OLD FIELDS

WYOMING

East Allen Lake.—The Medicine Bow Oil and Gas Company's Hintze-Government No. 1 extended the Allen Lake gas field 4 miles southeast. This well, which is on the east end of the fold, produced initially 25 million cubic feet of gas from the Sundance at 2,033–2,058 feet. There are 5 wells on this anticline, which is a narrow, sharp, curved fold, with about 900 feet of closure.

DEEP DRILLING

The Rocky Mountain region has been considerably behind other parts of the country in deep drilling. The operators in this region heretofore have been loath to start a well with a contract depth of more than 7,000 feet.

Badger Basin.—To the end of 1936 the Resolute Oil Company's N.P.R.R. No. 1 with a depth of 8,723 feet was the deepest well in the region. During 1936, that company completed a second well, State No. 1 in the second Frontier sandstone at 8,469 feet, making 200 barrels of 56° gravity oil. These wells are on a domal fold in the Fort Union (Eocene) with a closure of about 300 feet.

Borie.—At the end of 1936 the Amerada Petroleum Corporation was drilling Morton No. 1 in Sec. 13, T. 13 N., R. 68 W., Laramie County, Wyoming. This well was abandoned early in 1937 in Pennsylvanian red-beds at 9,385 feet and now holds the depth record for the Rocky Mountain region. This well, which was drilled on a seismograph "high," begins in Tertiary beds overlying the Laramie formation (Cretaceous). The Dakota sandstone was encountered at 8,689 feet.

IMPORTANT DRY HOLES

During 1936 the areas of most interest were in eastern Wyoming and western Nebraska, because of recent Sundance discoveries, and in eastern Colorado where deep production was anticipated. Later in the year northwestern Colorado attracted considerable interest on

account of the Power Wash discovery. Only outlying wildcat wells in these areas of particular interest are herein discussed.

WESTERN NEBRASKA

Hyannis.—The Byrd-Frost and Magnolia Petroleum Corporation's Abbott No. 1 in Sec. 22, T. 24 N., R. 38 W., near Hyannis, Grant County, Nebraska, encountered granite at 4,033 feet. This well drilled on seismograph information begins in recent deposits overlying Tertiary beds. This well logged 1,200 feet or more of unconsolidated sand.

WYOMING

Considerable interest was centered on the Laramie Basin after the discovery of oil in the Quealy and Medicine Bow anticlines in 1935. Also due to the activity at Lance Creek, much seismograph work was done during the year in eastern Wyoming and several wells were drilled, especially in the vicinity of Lance Creek.

Laramie Basin.—There were three failures in the basin on structures which had previously been tested to shallower horizons. Two of these wells were located on seismograph information on structures which had very little surface geology control.

TABLE I

Structure	*Location*	*County*	*Operator*	*Horizon Tested*	*Total Depth in Feet*
Little Laramie	NW., NW., SW., 4, 16 N., 75 W.	Albany	California Company	Sundance 2,319–50 Tensleep 3,860	3,886
James Lake	NW., NE., SE., 5, 17 N., 75 W.	Albany	James Lake Oil Co.	Muddy 4,328 Dakota 4,477 Sundance 4,569 Jelm 5,007	5,022
Dutton Creek	W.½, SE., 1, 18 N., 78 W.	Carbon	Union Oil Company Mutual Oil Syndicate	Sundance 5,334–50 Jelm	5,460

Jay Em.—An outlying well of considerable importance in eastern Wyoming, The Ohio Oil Company's Waggoner No. 1, center of NE., SE., Sec. 14, T. 28 N., R. 63 W., Goshen County, was abandoned in igneous rock at 3,062 feet. This well, which was located on seismograph information, begins in Tertiary beds overlying red-beds. A second well, Red Cloud Cattle Company's No. 1 in Sec. 28, T. 29 N., R. 62 W., on the same "high," was abandoned in March, 1937, at 3,090 feet. It is reported to have reached the upper part of the Minnelusa (Pennsylvanian) formation. No igneous rock was encountered.

COLORADO

In eastern Colorado during 1936, two wildcat wells were finished in basement igneous or metamorphic rocks and another, early in 1937, all at much shallower depths than generally expected. Some rather surprising stratigraphic relations were revealed. All three wells were located as a result of extensive seismograph surveys, although at one, the Beecher Island well, there is also some surface geology control.

Hyde.—The Indian Territory Illuminating Oil Company's Vorce No. 1, the center of NE., NE., Sec. 28, T. 1 S., R. 49 W., Washington County, encountered schist underlying Pennsylvanian beds at 6,937 feet, and was abandoned at 7,005 feet. This well began in Tertiary beds, overlying Pierre shale, and found the Dakota sandstone at 3,743 feet.

Beecher Island.—The Indian Territory Illuminating Oil Company's Strangways No. 1 in the center of NW., SW., Sec. 21, T. 2 S., R. 43 W., Yuma County, Colorado, encountered schist at 5,577 feet and was abandoned at 5,595 feet. Unlike the Hyde, this well found some Mississippian strata and had Cambrian overlying the schist. Strangways No. 1 started in Pierre shale and had the Dakota sandstone at 2,550 feet.

Galatea.—Early in 1937 the Gulf Oil Corporation completed and abandoned its Risser No. 1, center of SW., NE., Sec. 1, T. 17 S., R. 50 W., at 6,175 feet in granite, which was encountered at 6,150 feet. It is reported that this well had several small showings of oil in the Pennsylvanian and Mississippian beds. The surface formation is Tertiary overlying basal Pierre shale and the Dakota was reached at 1,445 feet.

Dry Mountain.—A test by the Anderson and Kerr Drilling Company and the Phillips Petroleum Company on the Dry Mountain anticline in Moffat County, Colorado, which was being drilled at the close of 1936, is now shut down at 2,497 feet. It is reported that this well found its first objective, the basal Wasatch, dry. This well, which is located in the center of SE., SE., Sec. 19, T. 9 N., R. 99 W., is an elongate anticline with 500 feet or more of closure with Green River (Eocene) beds at the surface.

UTAH

San Rafael.—Another test which was active at the close of the year has recently (June, 1937) been completed and abandoned in schist at 4,900 feet. This well, a joint test by The California Company and the Continental Oil Company, is on a huge anticline known

as the San Rafael swell. This anticline, which averages[6] 10 miles in width and 40 miles in length has the Coconino sandstone (Permian) exposed in the central part. Formerly this fold had been tested into the Pennsylvanian at 3,035 feet by the Carter Oil Company in 1921. This well was of particular interest on account of the large size of the fold and its geographical location.

PIPE-LINE CONSTRUCTION

During the year several new outlets for crude oil and gas were created by new pipe lines.

COLORADO

In Colorado the Hughes Estate built 15½ miles of 4½-inch line to Chama, New Mexico, on the Denver and Rio Grande Railroad (narrow gauge) and the Rocky Mountain Gas Company built 21.6 miles of 3-inch gas line from the Thornburg field to Craig, Colorado.

WYOMING

A new outlet was furnished the Lance Creek field by the construction of 39.7 miles of 6-inch line by the Illinois Pipe Line Company from Lusk to Fort Laramie, to connect with the Stanolind line which runs from Clayton, Wyoming, to Freeman, Missouri.

The Continental Oil Company built 19.8 miles of 2-inch gasoline line from Lance Creek to Manville on the Colorado and Northwestern Railroad.

The California Company built 19 miles of 4½-inch line from Quealy to Rock River on the Union Pacific Railroad in order to market Quealy oil.

MONTANA

Pipe-line construction in Montana was confined to the Cut Bank area. It consisted of a replacement by the International Refining Company of 4-inch pipe by 6-inch pipe in its lines from the Cut Bank field to Cut Bank, and from the Cut Bank field to Sunburst, a distance of 20 miles.

PRODUCTION

Production for the Rocky Mountain region appears small compared with other regions, and small in proportion to its areal extent. However, with the exception of the Salt Creek, and possibly Lance Creek anticlines, production ordinarily is found only a comparatively short distance vertically below the top of the folds. In addition there

[6] James Gilluly, "Geology and Oil and Gas Prospects of Part of the San Rafael Swell," *U. S. Geol. Survey Bull. 806-C* (1929), p. 72.

do not seem to be the prolific source beds which exist in other areas; consequently, the pools are mostly small. Table II shows Rocky Mountain production for the years 1934, 1935, and 1936 by states. Production shown for New Mexico is confined to the San Juan Basin, which is usually considered part of the Rocky Mountain operating division. The marked increase in Wyoming production was due mainly to the Lance Creek field, which at the end of the year was producing about 11,000 barrels per day.

TABLE II

State	*1934*	*1935*	*1936*
Colorado	1,121,193	1,519,358	1,622,168
Montana	3,519,430	4,913,896	5,798,661
New Mexico	373,287	377,011	378,926
Wyoming	12,529,830	13,778,377	14,284,429
Total	17,543,739	20,588,642	22,084,184

SUMMARY OF OPERATIONS

Table III is self-explanatory.

TABLE III

SUMMARY OF OPERATIONS—ROCKY MOUNTAIN REGION
END OF 1936

State	*Incomplete*	*Suspended*	*Total Completions*	*Wildcats*	*Abd. Dry or Water*	*Gas Wells*	*Oil Wells*
Colorado	23	8	22	12	13	1	8
Montana	43	10	235	17	44	32	159
New Mexico (Rky. Mtn.)	22	1	32	3	14	4	14
Utah	10	4	18	4	14	2	2
Wyoming	46	18	121	15	30	4	84
Totals	144	41	428	51	115	43	267

CONCLUSION

The year 1936 in the Rocky Mountain region as a whole was highly satisfactory, both from an operating and an exploratory viewpoint. Although there were several disappointments in wildcatting, yet the discoveries, especially by deeper drilling in old fields, were very encouraging, and many show greater reserves than were anticipated. The knowledge gained by the unsuccessful wildcats may be of inestimable value in directing future exploration.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 21, NO. 8 (AUGUST, 1937), PP. 1000-1005, 2 FIGS.

RECENT DEVELOPMENTS IN KANSAS AND NEBRASKA IN 1936[1]

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ABSTRACT

This summary of the activity, types of geological exploration used, and progress of development in Kansas in 1936, was prepared to provide a short statement for the benefit of those who have an interest in maintaining a file on the general application of geology to oil and gas development.

The demand for a summary of results of a year of the application of geology offers opportunity for a large amount of detail, omitted by the writers, which affects such a presentation favorably or unfavorably, according to the individual viewpoint of the reader.

KANSAS

A brief comparison with 1935 figures shows that core-drill work has increased approximately 260 per cent and seismograph work has decreased 40 per cent (Fig. 1) in Kansas in 1936.

Seismographs prospected 3½ million acres at an estimated cost of $650,000.00.

Core drills explored nearly a million acres (903,000) at a cost of approximately $250,000.00.

Subsurface work accounted for approximately 35 per cent of discoveries.

Core-drill work accounted for approximately 18 per cent of discoveries.

Wildcat work accounted for approximately 18 per cent of discoveries.

Surface work accounted for approximately 16 per cent of discoveries.

Seismograph work accounted for approximately 13 per cent of discoveries.

In general, the leasing and development in Kansas followed exploration work of 1936 and comprises approximately the same areas. The most notable departures from this customary routine were evident in Clark County and in southern Hamilton County, both these areas having been heavily checkerboarded or blocked before any

[1] Read before the Association at Los Angeles, March 18, 1937. Manuscript received, May 8, 1937.

[2] Consulting geologist.

[3] Assistant geologist, Phillips Petroleum Company.

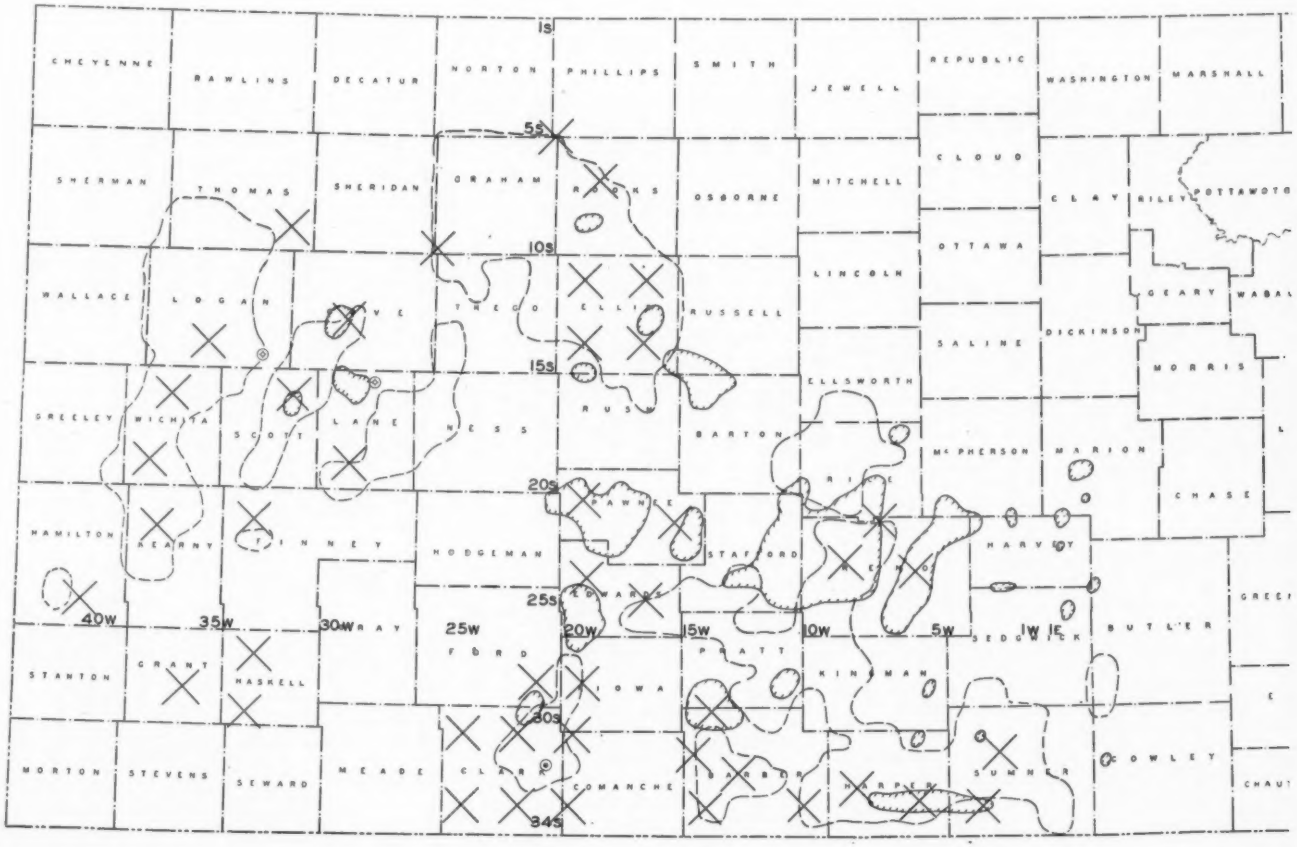


FIG. 1.—Exploration in Kansas, 1936. Areas enclosed by broken lines, prospected by seismograph; hachured lines, explored by core drill; crosses, actively leased.

appreciable amount of exploratory work had been done. With the exception of Ellis County, areas in which an active drilling campaign has been carried on were leased prior to 1936.

The major companies held approximately 5,800,000 acres of undeveloped leases, January 1, 1937.

Ellis County was the promoter's paradise of Kansas during 1936. Of thirty-three wildcat tests started, twelve have been completed as producers, with a total initial potential of 7,000 barrels per day. Only the Bemis pool, however, has been developed to any extent, the present potential being 52,000 barrels per day. Discoveries were fairly evenly divided between subsurface and core drill and surface, with seismograph and wildcat prospects trailing. Producing horizons include Pennsylvanian (Topeka and Lansing-Kansas City limestones) and Cambro-Ordovician (Arbuckle dolomite).

WESTERN KANSAS

In far western Kansas, seismographs have been active in the areas indicated and extensive checkerboard areas and numerous blocks have been leased in Logan, Wichita, Scott, and Kearny counties. Late in 1935 one wildcat was drilled in 15 S., 33 W., Logan County, on a large Cretaceous surface structure. The test was probably higher than normal on the base of the Pennsylvanian, but had only one small oil showing in the Topeka to Lansing-Kansas City limestone section. A wildcat is being drilled in 16 S., 28 W., Lane County, which is structurally high on the base of the Pennsylvanian. These tests and other dry holes give enough control to establish a possible subsurface "high" in the region of the Gove-Lane County line in an area which has been generally thought to be structurally low.

The southern Hamilton County lease activity is located on the reversal of the north-dipping Cretaceous rocks, and is characterized by one large lease block and heavy checkerboarding by several companies. Some seismograph work has been done with a proposed test rumored to be made in the spring of 1937.

Clark County has been the scene of the most rapid leasing activity Kansas has witnessed. It began in the middle of November, after the completion of Morrison No. 3 for 2,356 barrels, and at present includes practically all available acreage in Clark, southeast Ford, western Kiowa, western Comanche, and Harper County, Oklahoma. The discovery well was drilled offsetting an abandoned "Mississippi lime" gas well, and is producing from the Viola limestone (Ordovician) at 6,475 feet. Seismographs and core drills have moved into the area following leasing. This wildcat, located on the north flank of the Anadarko basin, opens a large area to prospecting.

The area of the Central Kansas uplift has received a steady development during the past year, with the majority of 1936 discoveries to its credit. Western Reno County was heavily leased, on the basis of core-drill work. Pawnee and Edwards counties have been heavily checkerboarded and blocked on seismograph and core drill. Western Barber, Sumner, and Harper counties have received a great deal of attention from several companies. Widespread checkerboard and several blocks of leases have been taken in the southwestern gas area by gas companies and carbon-black companies.

EASTERN KANSAS

The 1936 discoveries included six new oil pools and two gas fields. Potential production of the initial discoveries total 906 barrels per day.

Of paramount interest is a Burbank sand discovery in Sec. 20, T. 32 S., R. 5 E. This well is located on a projection of theoretical shore-line bar.[4]

Repressuring and water flooding of old sand trends is becoming more active in eastern Kansas.

NEBRASKA

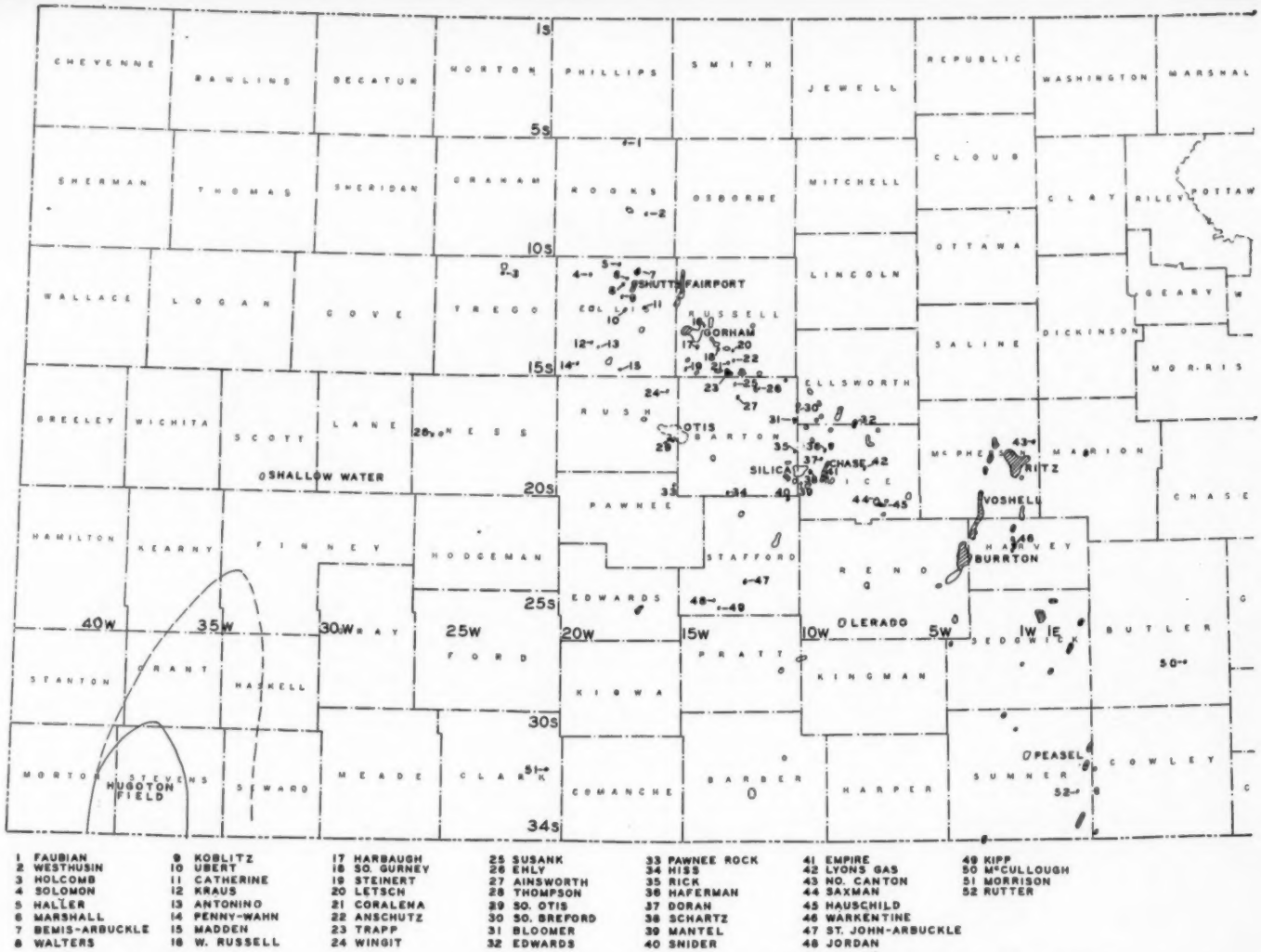
Acreage under lease in Nebraska is variously estimated from 1,500,000 to 2,000,000 acres, concentrated more or less on and flanking a hypothetical continuation of the Central Kansas uplift to the Chadron dome. The principal area of leasing is located in west-central Nebraska. Seismographs have been active. One dry hole was drilled in northern Grant County which reached granite at 4,036 feet.

DEVELOPMENT OF NEW FIELDS IN KANSAS

The producing horizons in new fields range in age from basal Cambro-Ordovician to Lower Permian. Estimated ultimate recovery of new Kansas pools stands second only to Texas, and is approximately twice as large as its next competitor. New Kansas pools are estimated to have developed 77,000,000 barrels reserve.

The Arbuckle dolomite was the producing horizon of more than half of the 54 discoveries of 1936. Several reports as to the number of fields discovered indicate more or less than 54. Some new fields were merged by development and areas that were recorded as more than one field have been merged by development and prorated as a single field during the year.

[4] N. W. Bass, "Origin and Distribution of Bartlesville and Burbank Shoestring Sands in Parts of Oklahoma and Kansas," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 21, No. 1.



1 FAUBIAN
2 WESTHUSIN
3 HOLCOMB
4 SOLOMON
5 HALLER
6 MARSHALL
7 BEMIS-ARBUCKLE
8 WALTERS
9 KOBLITZ
10 UBERT
11 CATHERINE
12 KRAUS
13 ANTONINO
14 PENNY-WAHN
15 MADDEN
16 W. RUSSELL
17 HARBAUGH
18 SO. GURNEY
19 STEINERT
20 LETSCH
21 CORALENA
22 ANSCHUTZ
23 TRAPP
24 WINGIT
25 SUSANK
26 EHLY
27 AINSWORTH
28 THOMPSON
29 SO. OTIS
30 SO. BREFORD
31 BLOOMER
32 EDWARDS
33 PAWNEE ROCK
34 HISS
35 RICK
36 HAFERMAN
37 DORAN
38 SCHARTZ
39 MANTEL
40 SNIDER
41 EMPIRE
42 LYONS GAS
43 NO. CANTON
44 SAXMAN
45 HAUSCHILD
46 WARKENTINE
47 ST. JOHN-ARBUCKLE
48 JORDAN
49 KIPP
50 McCULLOUGH
51 MORRISON
52 RUTTER

FIG. 2.—Development in Kansas, 1936. Solid, new fields numbered. Outlined, actively developed old fields. Crosshatched, old fields. Broken outline, gas areas, field area being enlarged.

Of increasing importance has been the discovery of commercial production in four new fields which produce from the basal sand of Cambro-Ordovician age where the Arbuckle dolomite is either very thin or absent. This horizon is a widely distributed sand, and may become important in future development.

An important pool has been developed in a sandy basal Pennsylvanian conglomerate in the Hauschild area of southeastern Rice County. The field is the second largest of 1936 discoveries, and is near the wedge edge of the "Mississippi lime" on the Central Kansas uplift. This is the first production of this type in this geological locality. Several hundred miles of Mississippian wedge-out conditions exist along the south side of the Central Kansas uplift.

The farthest north commercial production in Kansas was discovered in northern Rooks County, 30 miles south of the Kansas-Nebraska line. Two wells are now completed in the Pennsylvanian (Lansing-Kansas City limestone), with a potential of approximately 700 barrels.

The largest new field in Kansas is the Trapp, in southern Russell County, which produced 400,000 barrels to December 31, 1936.

DEVELOPMENT OF OLD FIELDS IN KANSAS

The largest amount of drilling was done in extending the Burrton, Silica, and Gorham fields.

The principal development activity was confined to, or was near, the Central Kansas uplift.

SUMMARY OF 1936 DEVELOPMENT IN KANSAS

Number of oil wells drilled	1,209
Initial production	1,298,869 barrels
Number of gas wells drilled	59
Initial production	850,000,000 cubic feet
Number of dry holes drilled	454
Total wells	1,722

KANSAS PRODUCTION SUMMARY

	Barrels	
Total 1936 production	57,102,123	
Monthly average	475,510	
Daily average	156,017	
Production from new fields	2,475,776	
Monthly average	206,315	
Daily average	6,764	
Production from new fields, per cent of total		4.34

Fig. 2.—Development in Kansas, 1936. Solid, new fields numbered. Outlined, actively developed old fields. Crosshatched, old fields. Broken outline, gas areas, field area being enlarged.

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DEVELOPMENTS IN OKLAHOMA IN 1936[1]

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ABSTRACT

Eleven gas wells and 23 oil wells were discovered by wildcat exploration in Oklahoma in 1936. No very important fields were opened, but several important extensions were developed. Exploration was carried on in large part by geophysical methods. Oil production for the state in 1936 was 200,880,705 barrels as compared with 182,596,874 barrels in 1935.

Although Oklahoma is credited with 34 wildcat discoveries in 1936, 11 gas wells and 23 oil wells, most of them were of minor rank and no fields of great importance were opened; however, several important fields discovered late in 1935, for example, the Mansion extension of the Oklahoma City field of Cleveland County, were largely developed in 1936. In addition, many important extensions both geographically and vertically took place during the year. The production for the state was 200,880,705 barrels compared with 182,596,874 barrels in 1935, or an increase of 18,283,831 barrels.

NORTHEASTERN DISTRICT

Northeastern Oklahoma underwent a revival during the year due to the success of certain secondary recovery methods applied to the older fields. The most important results were noted in the Delaware, Childers, Nowata, and Alluwe fields of Nowata and Rogers counties. The producing zone is the Bartlesville sand found at 500–800 feet, lensing out updip and combined with some structural terracing to effect a trap for oil. These fields have been producing for more than 20 years and recently, following an intensive study of sand conditions in various laboratories, both repressuring and water-flooding methods were found to be effective. Water flooding is the latest method to be applied and the first project was so successful that it stimulated the purchase of these older properties by several of the major companies. The secondary recovery methods have now spread over into Osage County and there is now considerable exploratory coring of sands, not only in the Bartlesville zone, but in other zones both deeper and shallower, It is believed that repressuring rather than water flooding

[1] Read before the Association at Los Angeles, March 18, 1937. Manuscript received, June 4, 1937.

[2] Sinclair Prairie Oil Company.

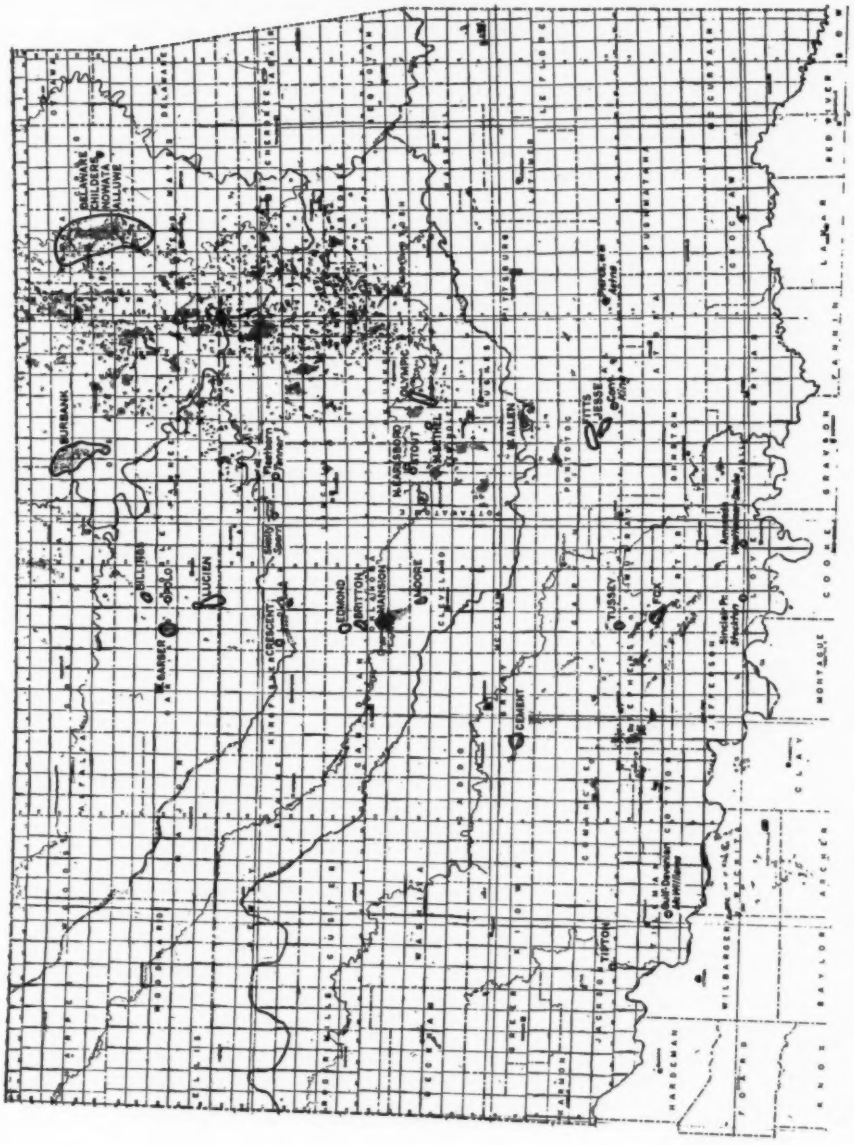

FIG. 1.—Map showing gas and oil wells developed by wildcat exploration in Oklahoma during 1936.

will be applied to these projects. The South Burbank field was extended west, but further limiting wells were drilled on the north, south, and east. The largest well in the field was completed during 1936, the Indian Territory Illuminating Oil Company and Sinclair Prairie Oil Company's No. 6, Tract 140, SE., SW., SE., Sec. 9, T. 25 N., R. 6 E., making 5,781 barrels initially with 3 million cubic feet of gas from the Burbank sand from 2,768 to 2,781 feet.

SOUTHEASTERN DISTRICT

In southeastern Oklahoma several deep and interesting failures were drilled during the year. Development in this area was stimulated by the discovery of the Fitts pool and many blocks were assembled on well known surface structures and geophysical "highs." The Lula structure, on an extension of the Savanna anticline, was tested by a deep failure in the NE., NE., NW., Sec. 31, T. 3 N., R. 9 E. This well crossed the Stonewall fault system at 3,390 feet and was drilled into the lower part of the Simpson formation, encountering salt water, and was temporarily abandoned.[3] The Childs dome, also on an extension of the Savanna anticline, was tested by a failure drilled in Sec. 30, T. 3 N., R. 10 E.

In the Franks graben itself the Fitts pool was greatly extended northeast by production from the Hunton limestone, Viola limestone, Bromide, and McLish formations. In addition, one well on the southeast edge of the field, the Magnolia Petroleum Company's Stattler No. 3, SE., SE., SW., Sec. 28, T. 2 N., R. 7 E., crossed the fault, drilling from the Hunton lime into the McLish formation and encountering oil in the Oil Creek formation from 4,547 to 4,625 feet, thus adding a new and lower producing zone to the Fitts pool. Several tests indicated that the Cromwell sand will produce in parts of this field, although no wells have been completed in the formation to date.[4] Limiting wells were drilled on the west and north edges and the fault bounding the south edge of the field was determined to trend in an arcuate fashion northeastward, thus further limiting production on the south and east. As rotary cuttings and cores have been faithfully taken in this field, from a depth within a short distance of the surface to the total depth, the subsurface conditions are accurately known and the Fitts pool presents as interesting a structural picture as exists in the history of oil development. Most of the faults are normal, the throws ranging from a few feet near the surface to many hundred feet in the pre-Pennsylvanian. In most of the wells the fault trace can

[3] This well has since been completed as a small producer in the Viola limestone.

[4] Note, June 4, 1937: several wells have now been completed in the Cromwell zone.

be accurately logged by the slickensiding and maceration noted in the cuttings. During 1936 the field produced 19,908,497 barrels[5] from all zones, the greater part of the production coming from the Simpson formation. Southeast of Fitts the Jesse pool, discovered in 1935, was further developed. Eighteen wells were drilled in this field with a potential of 39,327 barrels of oil per day. The field was limited on the south, subsurface control indicating a fault. Subsurface control in other directions, together with the size of production, indicates that the field will not extend much farther than its present development. Southeast of Jesse a surface structure within the Franks graben, which also seemed to hold some promise, was doomed to failure for pre-Pennsylvanian production by the Continental Oil Company's King No. 1, NE., SW., NE., Sec. 26, T. 1 N., R. 8 E., which was drilled to a total depth of 5,762½ feet in the McLish formation. The well was later plugged back and completed for approximately[5] 100 barrels per day from sands in the Atoka formation from 790 to 820 feet. Subsequent development substantiated steep dips shown on the surface and the shallow production will probably be limited to a very small area. In the Ouachita Mountain area Pierce *et al.* Aetna No. 1, NW., SW., NE., Sec. 10, T. 1 N., R. 13 E., was the first deep test; it was abandoned at 4,000 feet in the Stanley shale. This test was not especially significant, as it revealed no additional stratigraphic or structural information in this very complex area.

SEMINOLE AREA

The east flank of the Seminole area was especially active during 1936. The Olympic pool was extended several miles northeastward and now has a length of 6½ miles with an average width of ¾ mile. Production is from the Senora sand, found at approximately 1,800 feet. In general the northeastern extension has less favorable sand conditions and the wells are completed with somewhat lower initial production. Development has proved this to be a sand body lensing out updip toward the east, combined with a series of structural terraces westward. This type of production is considered very desirable by most of the operators despite the small initial production, as it will undoubtedly prove to be continuous for a considerable period of time. The North Bethel field was discovered by a test on a community block in the NE., NW., NW., Sec. 36, T. 10 N., R. 7 E., flowing 128 barrels the first 24 hours with 29¼ million cubic feet of gas from the Cromwell sand. Subsequent development has resulted in several much larger producers and also in limiting wells on the north and west.

[5] *The Oil and Gas Journal.*

In the north part of the Seminole area the Stout pool was opened by the Amerada Community's Stout No. 1, NE., NE., SW., Sec. 3, T. 10 N., R. 5 E., with an initial production of 579 barrels in 15 hours from the Hunton limestone at a depth of 4,500 feet. The well soon showed water and subsequent development has been on the whole disappointing because of water. The North Earlsboro field was also opened by the Amerada Petroleum Corporation's Klabzuba No. 1, SW., SW., SE., Sec. 35, T. 11 N., R. 5 E., with an initial production of 325 barrels in 12 hours from the "Wilcox" sand found at 4,622 feet. This area of production is now limited on the north, northwest, and east. The West Allen field was opened for further "Wilcox" sand development by the Sinclair Prairie Oil Company's Harjo No. 1, SW., NW., SE., Sec. 12, T. 5 N., R. 7 E., which flowed 541 barrels initially from the "Wilcox" sand, 4,340–4,350 feet. This development appears to be fairly well limited to a small area.

SOUTHERN DISTRICT

Southern Oklahoma had several deep and interesting tests which, however, developed no production of any importance. In the Fox field, the Carter Oil Company's Williams No. 1-A, SW., NE., SW., Sec. 27, T. 2 S., R. 3 W., after discovering oil in the Simpson formation in 1935, encountered mechanical difficulties and finally produced 500 barrels in 6 hours at a total depth of 8,105 feet, the oil coming from the Birds Eye limestone of the McLish formation, according to some geologists. Another test in the center, SW., SW., Sec. 28, T. 2 S., R. 3. W., encountered the pre-Pennsylvanian formations at a greatly lower structural elevation and cores indicated a steep dip so that the test was abandoned as a failure and appears to have discouraged further development, although several deep tests were scheduled for various fields in southern Oklahoma in 1936 in the hope of obtaining similar production. In Love County, approximately 12 miles south of the Healdton field, the Sinclair Prairie Oil Company's Stockton No. 1, SE., SE., SW., Sec. 26, T. 6 S., R. 2 W., was drilled to 8,472 feet after having encountered the Simpson formation below the unconformity at the base of the Pennsylvanian at 7,963 feet. Following acidization of the Birds Eye limestone, the well made 302 barrels of oil on August 14, but dropped to 47½ barrels swabbing. The gravity of the oil was 36°. The well was then plugged back and produced about 100 barrels per day from a sand in the Pennsylvanian group from 6,900 to 6,920 feet, the gravity of this oil being 33°. Southeast of Brock, the Amerada Petroleum Corporation's Westheimer-Daube No. 1, SW., SE., SW.,

Sec. 29, T. 6 S., R. 2 E., was drilled to a total depth of 6,798 feet in the Simpson formation, and, after making some oil from the Viola limestone, was finally abandoned as a failure. The Tussey field was extended northwest by Winkler and McQueen's Davis No. 1, completed for 692 barrels in 21½ hours, swabbing, the gravity being 25° Baumé. This well is located in the SW. ¼, Sec. 32, T. 1 N., R. 3 W., and subsequent development has proved a very sharp fold with some faulting. Most of the wells produce a few hundred barrels when completed. The field will probably be extended farther in 1937, but the fold is sharp.

SOUTHWESTERN DISTRICT

In southwestern Oklahoma, Tillman County, Gulf and Devonian McWilliams No. 1, NW., SW., SW., Sec. 15, T. 3 S., R. 17 W., encountered a stratigraphic condition of some importance, though the well was abandoned as a failure. The Viola limestone and a normal sequence of the Simpson and Arbuckle group were encountered beneath the unconformity at the base of the Pennsylvanian, this being the first well in this general area to have encountered pre-Pennsylvanian section as high stratigraphically as the Viola limestone. The Simpson formation was dominantly shale, with the sandstone reservoirs which characterize it farther north and east. The Tipton field in Jackson County received considerable interest after the Gulf Oil Corporation's Boucher No. 4, SE., SW., SW., Sec. 32, T. 1 N., R. 19 W., came in flowing 1,490 barrels in 8 hours from the Arbuckle limestone from 2,606 to 2,655 feet. The gravity was 41.5°. As this is the first Arbuckle limestone production in this part of the state, it created some excitement; however, as is characteristic of this formation, the well soon began making water and subsequent development has been rather disappointing because of the water problem. This field is apparently on a small dome. The Cement field in Caddo County witnessed a revival of interest after the Ohio Oil Company's Marchland No. 4, in Sec. 2, T. 5 N., R. 9 W., produced 1,077 barrels in 24 hours with 71 million cubic feet of gas from a sand in the Upper Pennsylvanian from 6,285 to 6,367 feet. The Magnolia Petroleum Company's Madrone No. 5 in Sec. 36, T. 6 N., R. 10 W., also produced 1,232 barrels in 24 hours with 2 million cubic feet of gas from a sand in the Pennsylvanian from 3,416 to 3,432 feet, the gravity being 36.3°.

CENTRAL DISTRICT

In central Oklahoma the most spectacular development was that of the so-called Mansion area of the Oklahoma City field. The excite-

ment was characterized by town-lot development in several exclusive residential tracts, under State land, and surrounding the State Capitol and Governor's mansion; however, production was soon limited by the finding of the water level on the north and west and limited on the east by steep dip or faulting, while on the south the main producing zone or "Wilcox" sand became absent by reason of truncation below the overlapping Pennsylvanian. This field is all the more remarkable as completions ranging from 10,000 to 20,000 barrels per day were common with a bottom-hole pressure as low as 300 pounds initially. This abnormally low bottom-hole pressure is due, of course, to the reduction of reservoir pressure by the main part of the Oklahoma City field on the south which has been developed since 1927. The fact that these wells would flow such large volumes of oil was surprising to many of the operators. The depth of the wells is about the same as in the Oklahoma City field, 6,000–6,200 feet. Recovery as of January 1, 1937, was 16,147,624 barrels. Most of the wells are now being flowed by gas lift or produced with Reda pump installations.

Development of the Moore pool was also an outstanding feature of 1936. This pool had been opened in 1935 by the Sinclair Prairie Oil Company's Franklin Community No. 1, SE., NW., SE., Sec. 21, T. 10 N., R. 2 W., a tremendous gas well, which was later deepened and finally completed as an oil well. To date the field has 18 producers. The average depth is about 7,300 feet. The production is from the Second "Wilcox" sand, with normal pressure for this depth and with large initial productions, the potentials ranging from 20,000 to 30,000 barrels per day for the most part. The field has been limited on the east, south, and west and is now in the process of being extended northwest. It is a faulted dome elongate northwest and southeast with the fault on the east flank. The central part of the structure is covered by a communitization, with several companies owning the outside acreage now being developed or soon to be developed. The gravity of the oil is 41°–42°.

North of the Oklahoma City field the Britton area in T. 13 N., R. 3 W., has in general proved disappointing during 1936, most of the wells being restricted to Simpson limestone production, which showed a rather marked decline.

The Edmond field was extended west by Simpson limestone production, which also appears to be proving erratic and is characterized by rapid water encroachment; however, the deepening of several wells and drilling of additional wells within the Edmond pool itself developed producers with very large initial production figures, this production being from the "Wilcox" sand.

The Crescent field was also characterized by large producers in the Second "Wilcox" sand, the Carter Oil Company and Gulf Oil Corporation's Walker No. 3, NW., NE., NE., Sec. 33, T. 17 N., R.4 W., having produced initially and potentially 64,679 barrels of oil with 80 million cubic feet of gas from the Second or lower "Wilcox" sand from 6,182 to 6,191 feet. This production will be limited to a small area in the top part of the structure and some of the wells have already shown water on deepening.

In Noble County a new field was opened on a community block north of the present Lucien development, this test being located in the center, SW., NW., Sec. 31, T. 21 N., R. 2 W. The First or upper "Wilcox" sand was found from 5,373 to 5,384 feet and the well completed with an initial production of 1,815 barrels in 9 hours. As this is the only well completed to date, the significance of this discovery is not yet evident.

Also in Noble County, the Phillips Petroleum Company and Shell Petroleum Corporation's McCaughtry No. 1-A, NW., NE., NE., Sec. 21, T. 23 N., R. 2 W., found the "Wilcox" sand from 4,240 to 4,258 feet and produced 400 barrels an hour from this formation. This discovery confirms the suspected rim of "Wilcox" sand thought to exist around the Arbuckle and lower Simpson core of this area. Some of the subsequent wells have been drilled into the lower Simpson formation, missing the "Wilcox" sand, while several others have encountered prolific production in the "Wilcox" sand. The tracing of this belt seems to be somewhat hazardous and the development has been rather slow considering the size of the initial productions, which have been as high as 35,000 barrels per day. A well is now proposed for the north flank and will be an interesting test for this side of the field.

The Polo field in T. 22 N., R. 2 W., was fairly well limited during 1936 and little more drilling is expected.

The Lucien field was extended south and east and into T. 19 N., R. 2 W., the production being somewhat below the average of the wells on the north in the central part of the field. A further extension of several locations in this direction is expected.

Two miles northeast of the Agra field Fleetborn's Tanner No. 1, NW., NW., SE., Sec. 28, T. 17 N., R. 5 E., found the "Wilcox" sand from 3,986 to 3,997 feet, making 4 million cubic feet of gas with a spray of oil, and after being deepened to the Second "Wilcox" sand from 3,985 to 4,001 feet, it made 70 barrels in 24 hours, cutting 2 per cent salt water. This well probably opens a new small area of "Wilcox" sand production but is not considered significant.

Approximately 7 miles southwest of the Ripley field, the Skelly Oil Company's Sporn No. 1, NW., NE., SW., Sec. 21, T. 17 N., R. 3 E., found the "Wilcox" sand at 4,546 feet, and made an estimated volume of 50 million cubic feet of gas opening a new small area of production believed to be of minor importance. The well is now testing the Second "Wilcox" sand.

Following the results at Billings, a deep test was drilled on the west flank of the Garber field in the NE., SW., Sec. 23, T. 22 N., R. 4 W., but was abandoned as a failure at 5,449 feet in the Arbuckle limestone. This well was designed to test a possible rim of "Wilcox" sand around the Arbuckle core characterizing the central part of the Garber field. The "Wilcox" sand was encountered, but contained salt water.

GEOLOGICAL EXPLORATION

Geological exploration was carried on largely by means of geophysical instruments in 1936, the average number of seismograph parties being 24. Most of the work was confined to southeast, eastern, and central Oklahoma. One to three core drills operated during the year while the number of surface parties was believed to be seven. Most of the surface investigation was confined to the flanks of the Arbuckle, Wichita, and Ouachita mountains. Some companies did considerable aeroplane mapping as a basis for surface detail and several have undertaken an extensive study of these maps in the office, using several types of equipment.

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DEVELOPMENTS IN NORTH-CENTRAL TEXAS AND THE PANHANDLE, 1936–1937[1]

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ABSTRACT

Production in north and west-central Texas is principally from beds of Pennsylvanian age and is controlled both by structural and stratigraphic conditions.

The largest single unit of new production discovered and developed in north-central Texas during 1936 is from lenticular Strawn sands at a depth of about 2,000 feet in the Anderson and Kerr field located southeast of the town of Gainesville, Cooke County. The field is located on an eastward plunging structural nose situated on the northeastern flank of the Muenster arch, is defined by 104 oil wells and 16 dry holes, and covers about 550 acres. With a 40-barrel per well allowable, the daily production is about 4,000 barrels of 40° gravity oil.

The greatest unit of drilling activity in the district today is north and east of the town of Bryson, southwestern Jack County, where at the present time approximately 70 operations are under way. During the year considerable new production of 39°–40° gravity oil was developed from lenticular sands in the Strawn at an approximate depth of 2,975 feet.

The Rathke field, situated north of the town of South Bend, south Young County, was further developed during 1936. Production is from a Smithwick sand, the Caddo limestone, of the Smithwick section, and from upper Marble Falls sand and sandy limestone, all of Bend age, from depths of 3,600 to 4,000 feet. The oil is 38° gravity.

In Shackelford County the Bluff Creek field was extended, and in Jones County new extensions were made to the Leuders and Hawley fields, all producing from the Cisco. A new area of Cisco production was discovered in Jones County about 2¼ miles east of the Hawley field. In western Hamilton County a new gas area was discovered with production from Bend limestone. Scattered new production was developed in several additional counties throughout the west-central and north Texas districts.

Early in 1936 interest was stimulated in Montague, Cooke, and Grayson counties, Texas, by the discovery of oil in limestone beds of Simpson age in the Fox field, Carter County, Oklahoma. Considerable seismograph work and leasing were done in this area of Texas. Two deep tests were drilled in search of Simpson production, and a third is now drilling. On development of production in the Altus field, Jackson County, Oklahoma, and, later in the year, when deep drilling disclosed the presence of Simpson in Tillman County, Oklahoma, interest gradually spread westward to northwestern Wichita, northern Wilbarger, Foard, and Hardeman counties, Texas, where considerable seismograph work has been done and is still under way.

The Panhandle oil and gas field is situated on the Amarillo uplift, petroleum accumulation being found in the "Panhandle lime" and granite wash of Lower Permian and Upper Pennsylvanian age. In general, gas production is confined to the structurally higher part of the field and oil production is found lower on the structure and principally on the northern flank.

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Appreciation is expressed to John E. Galley, who furnished the map and most of the data for the Panhandle; to Don Chapell, who contributed geological data for the cross sections in southern Oklahoma; to M. G. Cheney and T. F. Petty, who aided with data on the west-central Texas area; and to others, who through discussion and encouragement aided in the preparation of this paper. For permission to publish this paper, the writer is indebted to the management of the Shell Petroleum Corporation and especially to W. van Holst Pellekaan and Roy R. Morse.

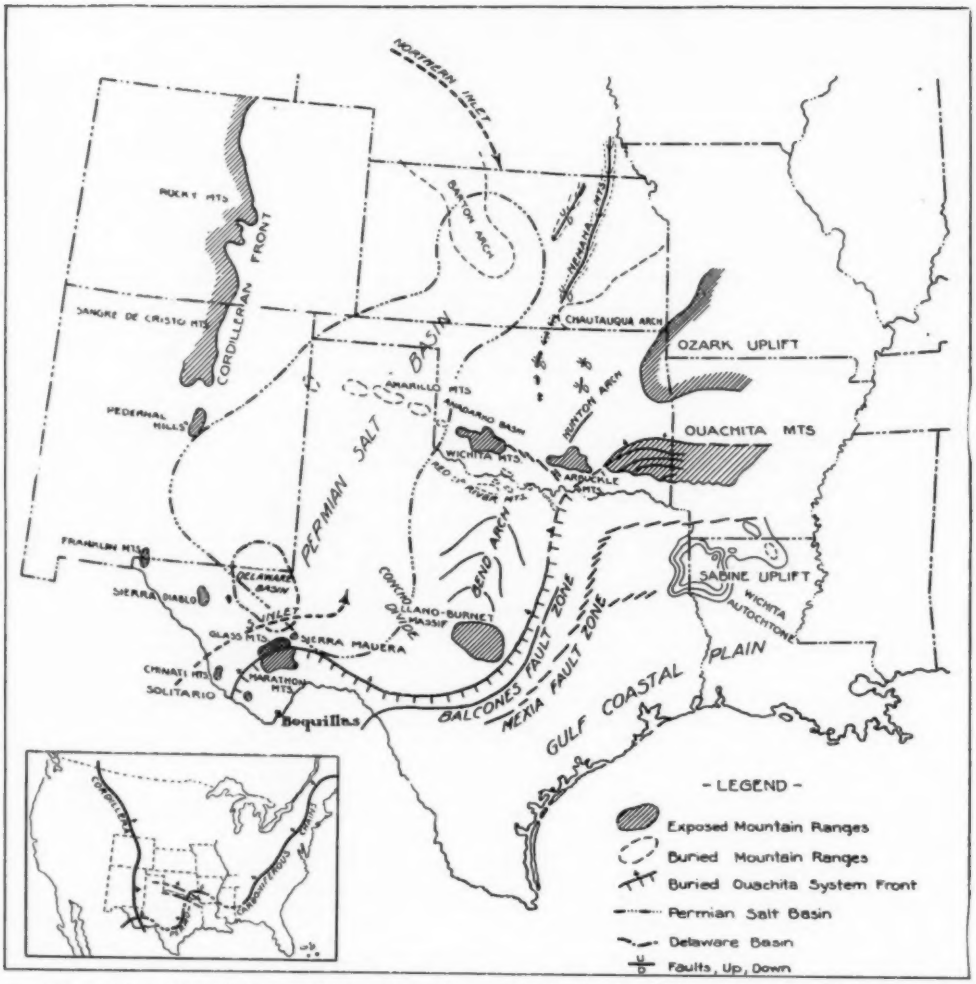


FIG. 1.—Late Paleozoic tectonic features in south-central United States. Width of area shown in map, approximately 1,400 miles. Redrawn and revised by Sidney Powers. From W. A. J. M. van Waterschoot van der Gracht, "Permo-Carboniferous Orogeny in South-Central United States," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 15, No. 9 (September, 1931), Fig. 1, p. 993.

A northwestward extension of production occurred in the Stinnett area, west-central Hutchinson County, where nine oil wells have been completed and several tests are drilling. Recently, a gas well was completed in northern Hansford County directly south of the Oklahoma state line.

Moore County was the scene of the larger part of new activity during 1936, as many old 10-year leases had to be developed, renewed, or dropped. Natural gas is the most important production in the county, with sweet gas in the southern part and sour gas in the northeastern. By Railroad Commission order only sour-gas residue from gasoline plants can be used in the manufacture of carbon black, with the result that the past year witnessed a great expansion of the natural-gasoline and carbon-black industry in Moore County to draw on the sour-gas reserve.

INTRODUCTION

In this paper on recent developments in north-central Texas and the Panhandle, no attempt is made to cover all the new producing areas discovered during the past year in a region (especially north-central Texas) which has been noted for its numerous small producing areas outlined each year in the past and which, no doubt, will continue in the future to supply a similar record of small discoveries. On the contrary, only the more important new producing areas are mentioned, some general statistics on production and wells drilled are presented, and, with the aid of generalized cross sections, a general picture of the regional geology is displayed. In addition, a few deep tests which have been of unusual interest are discussed.

GENERAL GEOLOGY

Figure 1 shows the regional geological setting of the north-central Texas and Panhandle regions.[3] On it are shown the Llano uplift of Texas, the northward plunging Bend arch, the buried Red River uplift, the Wichita and Arbuckle mountains of Oklahoma, the buried Amarillo granite ridge of the Texas Panhandle, the Permian salt basin, and, on the east, the Ouachita Mountains of Oklahoma and Arkansas, and the thrust fault zone of these mountains extending southwestward into Texas.

In Figure 2 the lower west-to-east section shows the Bend arch unconformably overlain by the Strawn. The main features are the eastward dipping Cretaceous, the westward dipping Permian and Pennsylvanian above the Bend with eastward thickening of Strawn, and the Bend arch. The middle cross section begins at McCulloch County, passes northward along the Bend arch to southeastern Archer County, and thence eastward across the Muenster arch and through a section of the Ardmore basin to the Criner Hills, Oklahoma. As the vertical scale is nearly 100 times the horizontal, the section appears some-

[3] W. A. J. M. van Waterschoot van der Gracht, "Permo-Carboniferous Orogeny in South-Central United States," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 15, No. 9 (September, 1931), p. 993.

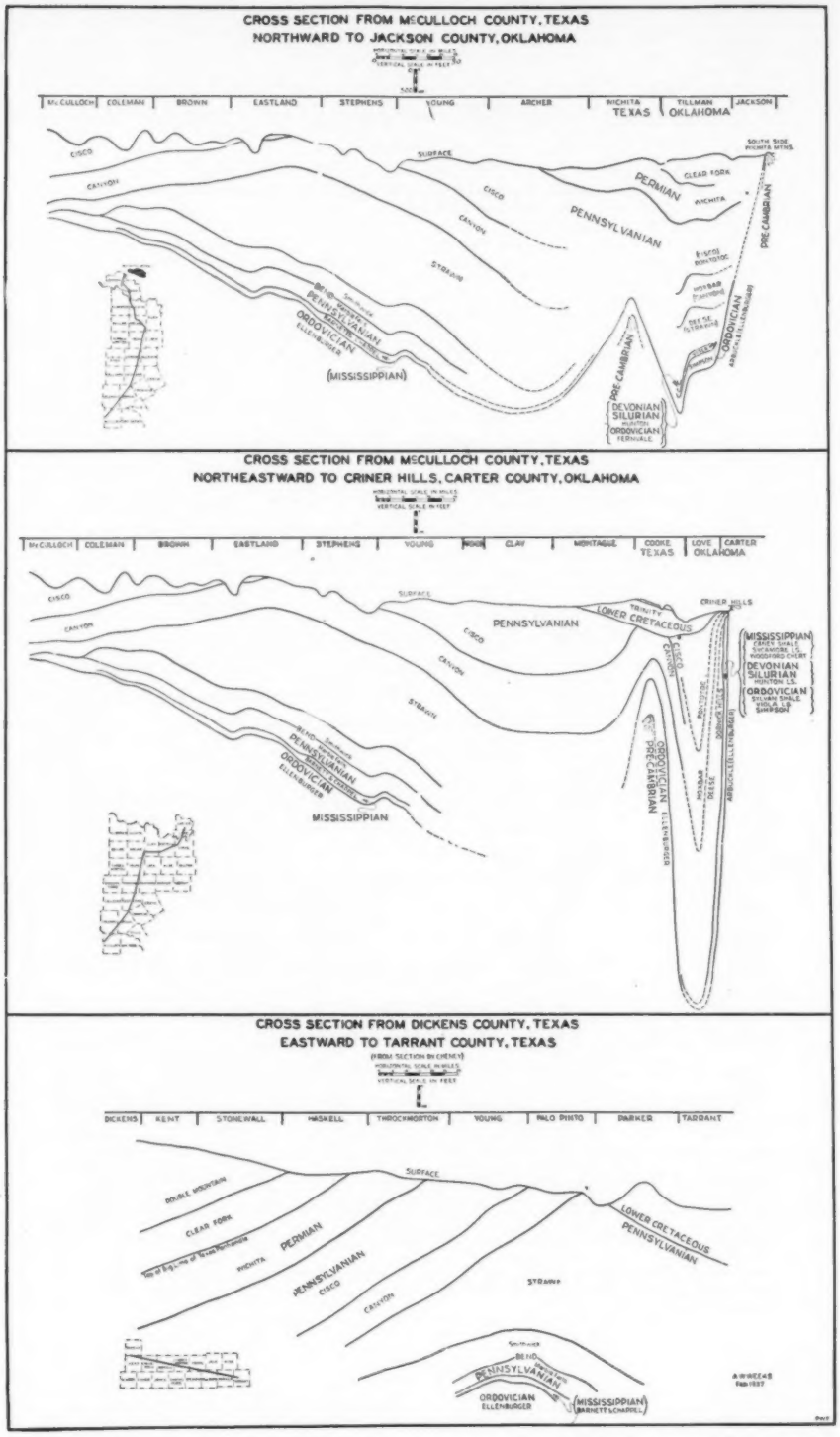


FIG. 2.—Cross sections in north-central Texas and southern Oklahoma (lower section and part of middle and top sections south of Young County prepared with aid of well-log sections by Cheney in *University of Texas Bull. 2913*). In upper section, Sylvan is present between Hunton and Fernvale (omitted through oversight).

what cramped in the Ardmore basin. It is to be noted, however, that the section in Oklahoma from Arbuckle (Ellenburger) to Mississippian, which includes Simpson, Viola, Sylvan, and Hunton, is absent so far as known in north-central Texas except in northeastern Cooke County and vicinity, where part or all of these formations are present. The upper section extends northward across the Electra arch and the basin south of the Wichita Mountains and terminates in granite on the south side of the mountains. Here again, some Middle and Upper Ordovician, Silurian, and Devonian formations are present in the basin between the Electra arch and the Wichita Mountains but are absent on the south.

PRODUCTIVE SECTION, NORTH-CENTRAL TEXAS

Oil is produced in north-central Texas principally from beds of Pennsylvanian age (Fig. 3).[4] In the northern part, along the Electra arch and immediately south of it, and also in the western part of the district, oil is produced principally from Cisco sands and sandy limestones. Oil is obtained also from beds of Canyon age from fields in central Wilbarger and Foard counties and from Chalk Hill field in north-central Archer County. In the northeastern part of the district along the Muenster arch, oil is obtained from Cisco, Canyon, and Strawn beds in Montague and Cooke counties. The Strawn and Bend formations are the principal producers in the south-central part of the district. The upper part of the Ellenburger section, underlying younger formations, is producing or has produced oil at the Bulcher, Andress, and Pilot Point fields in Cooke County high on the Ellenburger ridge and at various scattered points in the central and southern parts of the north-central Texas area.

Production throughout the area is controlled both by structural and stratigraphic traps.

[4] Part of the north Texas portion of the map showing oil fields was taken from a map prepared for M. M. Garrett, who kindly permitted its use. The remainder of the oil-and-gas-field map, especially west-central Texas and southern Oklahoma, was compiled from State, United States Government, and private sources.

Because of controversy regarding names and divisions of units within the Double Mountain group, boundaries are not indicated for units of this group above the San Angelo sandstone on the composite section of north and west-central Texas. Most geologists in north-central Texas use either the top or the base of the Coleman Junction limestone as the base of the Wichita group. On the composite section the base of the Wichita (Albany) is placed at the base of the Coleman Junction limestone, as originally defined by Drake in the *Fourth Annual Report* of the Geological Survey of Texas, published in 1892. In the University of Texas *Bulletin 2132*, published in 1921, Plummer and Moore, finding no definite evidence to indicate that the Coleman Junction was of Permian age and recognizing the bed as a good horizon marker, considered it the topmost bed of the Cisco group of Pennsylvanian age. In the University of Texas *Bulletin 3232*, published in 1932, Sellards lowered the base of the Wichita to the top of the Camp Colorado limestone, because of paleontologic evidence indicating the base of the Permian to be at least as low as the top of this limestone.

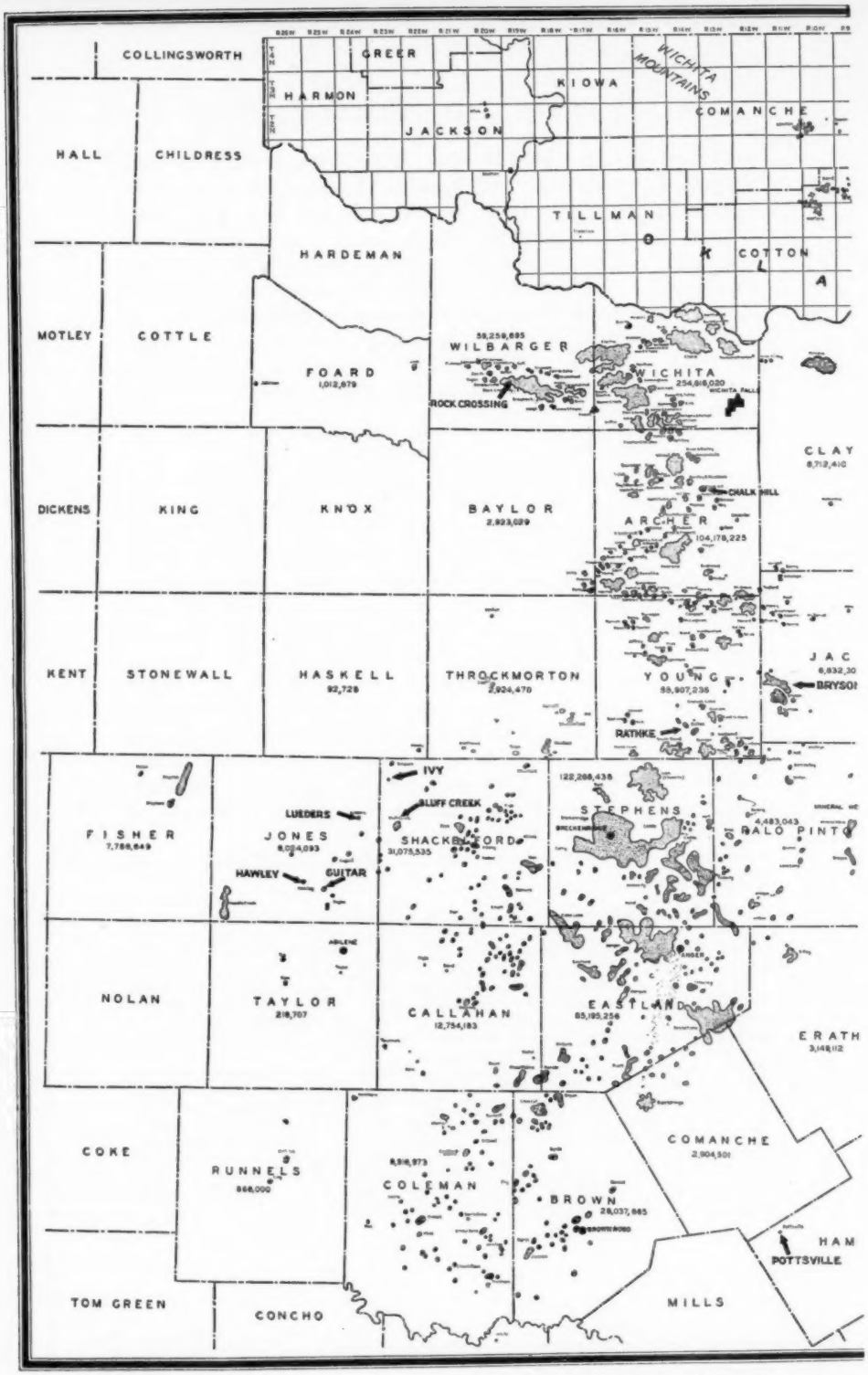


FIG. 3 (left half).—Oil and gas fields of north-central Texas and southern Oklahoma with geologic sections.

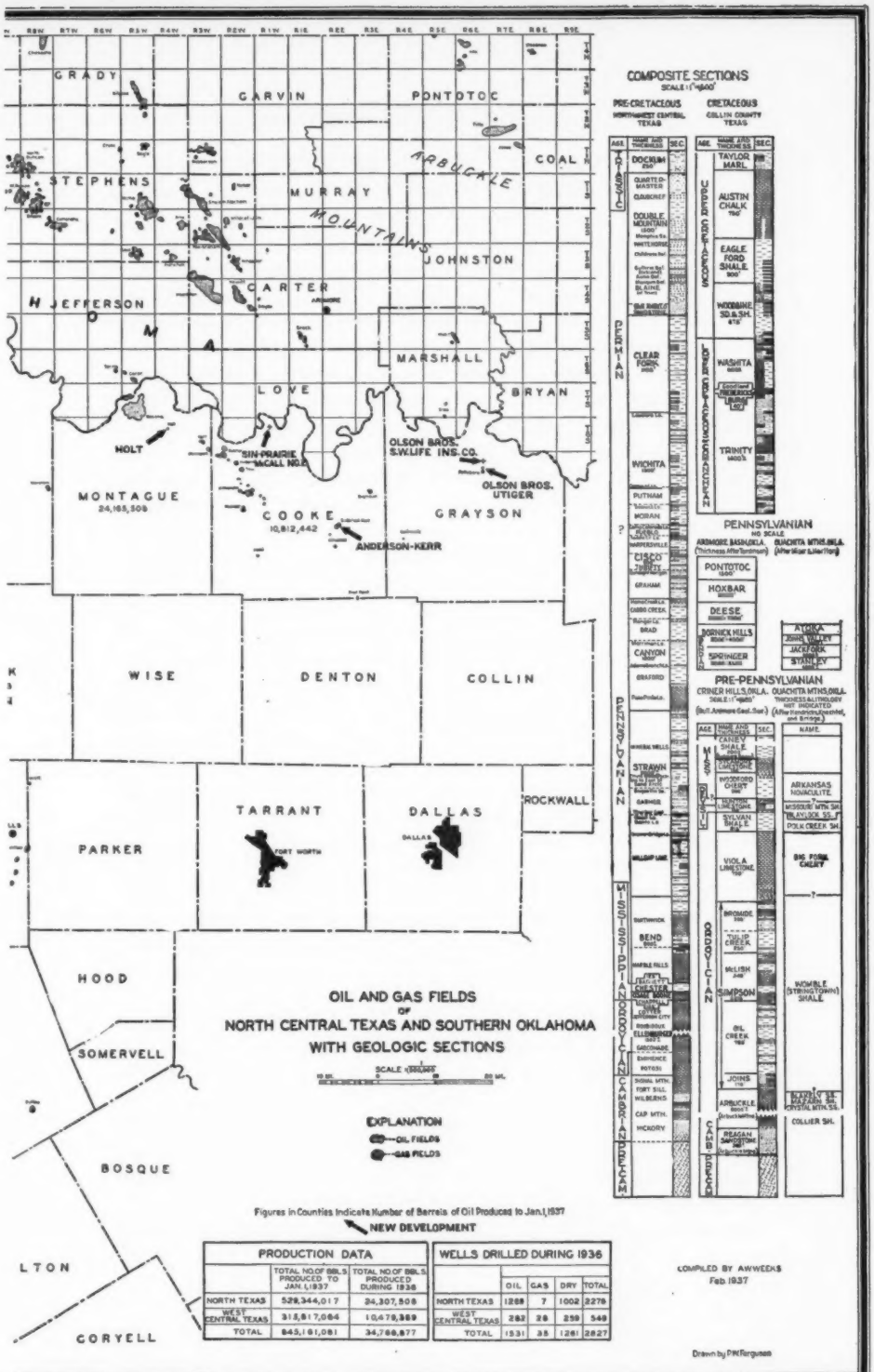


FIG. 3 (right half).—Oil and gas fields of north-central Texas and southern Oklahoma with geologic sections.

INTERESTING AREAS DISCOVERED OR FURTHER DEVELOPED DURING PAST YEAR IN NORTH-CENTRAL TEXAS

Hamilton County.—In western Hamilton County, following exploration with the seismograph, a gas area was discovered with production from the Bend limestone in two wells drilled by the Seaboard Oil Corporation. The second of these, before plugging back for completion in the Bend, penetrated approximately 2,350 feet of the Ellenburger without reaching the base. This is perhaps the greatest amount of Ellenburger section penetrated by any well in north-central Texas. The Ellenburger section thins in a westward direction.

Shackelford and Jones counties.—In western Shackelford County the Bluff Creek field was extended. In December, 1936, it contained 171 oil wells covering 1,600 acres, or an increase of 660 acres and 77 wells during 1936.

A new producing area, Ivy, was recently discovered in northwestern Shackelford County by the Owens-Snebold Oil Corporation's Ivy No. 1, Sec. 159, B.B.B.&C. R.R. Company Survey, completed in February, 1937, in sandy limestone from 1,929 to 1,937 feet, and prorated to 63 barrels per day. The gravity of the oil is 37.5°.

In Jones County extensions were made to the Leuders and Hawley fields, and a new producing area, Guitar, was discovered about 2½ miles east of the Hawley field. In December, 1936, Hawley covered approximately 580 acres, in comparison with 320 at the beginning of the year. This field is producing 44° gravity oil from Cisco sands and sandy limestones ranging in depth from 1,900 to 2,200 feet. Initial yields range up to 3,000 barrels per day.

All new production in these counties is from the Cisco and is controlled largely by structure.

During the past year considerable core drilling was done and is still under way throughout much of eastern Jones County, which caused drilling for oil and may lead to the discovery of additional fields.

Young County.—The Rathke field, situated north of the town of South Bend, South Young County, where operations are conducted in an area about 4 miles long northwest and southeast and about 1 mile wide, was further developed during 1936. Production is from a Smithwick sand, the Caddo limestone of the Smithwick section, and from the upper Marble Falls sand and sandy limestone, all of Bend age, from depths of about 3,600–4,000 feet. By setting two strings of pipe, both Smithwick and Marble Falls horizons, where each is oil-bearing, are produced simultaneously, the upper through a bradenhead. Wells

in the upper or Smithwick "pay" are completed for an average of about 600 barrels per day after acidizing and sometimes shooting; wells in the lower or Marble Falls may average about 800 barrels per day. Some wells are considerably larger and others are smaller, depending on structure and porosity in the productive section. The oil is 38° A.P.I. gravity. At present, the maximum daily allowable per horizon in south Young County, with a potential of 500 barrels or more, is 100 barrels per day. Holes are drilled with cable tools.

Jack County.—The largest unit of drilling activity in the district at present is in the vicinity of the town of Bryson, southwestern Jack County, where at present more than 50 operations are under way in an area approximately 7 miles long northwest and southeast and 4 miles wide. During the year considerable new production of 38° A.P.I. gravity crude was developed from lenticular sands in the Strawn on a northwestward plunging structural nose. Principal production is obtained from a sand at a depth of approximately 2,950 feet, or 1,850 feet below the base of the Canyon, and minor production is being developed from a lenticular sand at a depth of approximately 2,250 feet. Holes are drilled to the top of the sand with rotary and then completed with spudder, as rotary pump pressure kills a potential well. Dry holes and poor wells caused by poor sand conditions are found among good wells ranging up to 500 barrels or more per day. The maximum daily proration allowable per well is 65 barrels. At this time it may be mentioned that the higher daily well allowables in north-central Texas compared with the East Texas field maximum of 20 to 22 barrels, tends to offset somewhat the natural exploration and development hazards.

Archer County.—The past year several additional tests were drilled in the Chalk Hill field, discovered in March, 1931, and from which the only Canyon production in the county is obtained. The sand has a thickness of approximately 20 feet and is encountered at a depth of about 2,200 feet. About 700 acres have been proved for production. Estimated per acre oil yield ranges up to and above 20,000 barrels for the best part of the field. Scientific production methods, aided by a natural water drive, make a large recovery estimate appear reasonable. This is one of the richest fields discovered in recent years in north Texas. Production is controlled by structure.

Wilbarger County.—In February of this year in the Rock Crossing field, central Wilbarger County, from which production previously had been obtained principally from the Cisco and upper part of the Canyon formations, Phillips Petroleum Company's Waggoner No. 51 was completed, with a production of nearly 100 barrels of oil per

hour at a total depth of 3,071 feet, 500 feet below the top of the Canyon. The finding of production on the Rock Crossing structure some distance below the top of the Canyon is of interest, as previous production from this formation in Foard and Wilbarger counties was obtained from that part of the Canyon section immediately below the Cisco.

Montague County.—Late in 1936 and early in 1937, the Sinclair-Prairie Oil & Gas Company began the development of some shallow production of Canyon age in the Holt area, northeastern Montague County, where 31° A.P.I. gravity oil is encountered at a depth of approximately 1,750 feet. Four oil wells have been completed, the largest having a production of 240 barrels of oil per day.

Cooke County.—The largest single unit of new production discovered and developed in north Texas during 1936 is from lenticular Strawn sands at a depth of about 2,000 feet in the Anderson and Kerr field located southeast of the town of Gainesville, Cooke County. The field is located on an eastward plunging structural nose situated on the northeastern flank of the Muenster arch, is defined by 105 oil wells and 16 dry holes, and covers about 550 acres. With a 40-barrel per well allowable, the daily production is about 4,000 barrels of 40° A.P.I. gravity oil.

PRODUCTION AND DRILLING STATISTICS, NORTH-CENTRAL TEXAS

For convenience in presenting production figures and number of tests drilled, the dividing line between north and west-central Texas is drawn along the south line of Throckmorton, Young, and Jack counties. In Figure 3 are shown total production figures to the end of 1936 for both of these districts, for the entire north-central Texas area, and for each county (also see Table I). Most of the new production in north Texas during 1936, approximately 1 million barrels, was obtained from the Anderson and Kerr field, Cooke County, the Chalk Hill field, Archer County, the Bryson area, Jack County, and the Rathke area, Young County. Extensions to the Bluff Creek field, Shackelford County, and to the Leuders and Hawley fields, Jones County, accounted for most of the new production in the west-central Texas district.

The west-central Texas proration district, which includes all counties on the south and also south Jack, south Young, and Throckmorton, has a daily oil allowable for March of approximately 64,000 barrels; the north Texas proration district has a daily oil allowable of about 66,000 barrels.

As indicated in Figure 3 and Table II, 2,278 tests were drilled and completed in north Texas during 1936, or approximately 44

TABLE I

OIL PRODUCTION IN NORTH TEXAS (WICHITA FALLS) DISTRICT
(*Figures in Barrels*)

County	*Total to End 1936**	*During 1935†*	*During 1936‡*
Archer	104,178,225	6,575,589	5,316,228
Baylor	2,923,029	606,261	1,171,269
Clay	6,712,410	185,881	185,475
Cooke	10,812,442	762,069	1,637,230
Foard	1,012,679	271,350	175,687
Jack	6,832,303	485,095	899,976
Montague	24,165,508	2,027,893	1,993,359
Throckmorton	2,924,470	169,554	163,540
Wichita	254,616,020	5,565,922	5,359,111
Wilbarger	59,259,695	2,977,317	3,290,316
Young	55,907,236	3,605,347	4,115,317
Total	529,344,017	23,232,278	24,307,508

OIL PRODUCTION IN WEST-CENTRAL TEXAS (CISCO) DISTRICT
(*Figures in Barrels*)

County	*Total to End 1936**	*During 1935†*	*During 1936‡*
Brown	28,037,865	704,561	641,327
Callahan	12,754,183	560,098	589,542
Coleman	8,916,973	464,107	411,792
Comanche§	2,904,501	51,103	25,449
Eastland§	85,195,256	1,082,947	1,064,359
Erath§	3,149,112	50,360	44,358
Fisher	7,786,649	1,993,307	1,641,519
Haskell	92,728	6,654	6,093
Jones	8,024,093	685,060	1,606,471
McCulloch	981	981	000
Palo Pinto	4,483,043	143,365	130,585
Runnels	866,000	190,585	91,535
Shackelford	31,075,535	2,130,955	2,526,335
Stephens	122,268,438	1,820,949	1,671,895
Taylor	216,707	35,013	28,109
Total	315,817,064	9,920,045	10,479,369

	Total to End 1936	*During 1935*	*During 1936*
Grand total (Both districts)	845,161,081	33,152,323	34,786,877

* A.I.M.E. total to end 1935 plus R.R. Comm. figures for 1936.
† A.I.M.E. figures.
‡ R.R. Comm. figures.
§ Desdemona field production totaling approximately 22,671,000 to end 1936 and 214,000 during 1936 divided among Comanche, Eastland, and Erath counties on assumption 1/9, 2/3, and 2/9 went to each respectively.

per week, as compared with 549, or approximately 10 per week, in the west-central Texas district. Activity is now at a higher rate.

IMPORTANT WILDCAT TESTS AND GENERAL ACTIVITIES, NORTH-CENTRAL TEXAS

Early in 1936 interest was stimulated in Montague, Cooke, and Grayson counties, Texas, by the discovery of oil in limestone beds

TABLE II

TESTS DRILLED IN NORTH TEXAS (WICHITA FALLS) DISTRICT DURING 1936

County	*Oil*	*Gas*	*Dry*	*Total*
Archer	223		251	474
Baylor	23		30	53
Childress			1	1
Clay	15		20	35
Cooke	256	2	110	368
Cottle			1	1
Denton			4	4
Foard	2		1	3
Grayson			3	3
Hall			1	1
Jack	129	2	66	197
Montague	81		29	110
Throckmorton	5	2	7	14
Wichita	187		136	323
Wilbarger	67		41	108
Wise			2	2
Young	281	1	299	581
Total	1,269	7	1,002	2,278

TESTS DRILLED IN WEST-CENTRAL TEXAS (CISCO) DISTRICT DURING 1936

County	*Oil*	*Gas*	*Dry*	*Total*
Brown	9	2	15	26
Callahan	18	6	42	66
Coleman	4	2	8	14
Comanche	2	3	3	8
Concho			2	2
Eastland	10	1	19	30
Fisher	17		6	23
Hamilton		2	1	3
Haskell			1	1
Jones	60		41	101
Palo Pinto	5	1	10	16
Shackelford	131	7	102	240
Stephens	6	3	6	15
Taylor		1	3	4
Total	262	28	259	549

	Oil	*Gas*	*Dry*	*Total*
Grand total (Both districts)	1,531	35	1,261	2,827

of Simpson age in the Fox field, Carter County, Oklahoma. Considerable seismograph work and leasing was done in this area of Texas, and in north-central Cooke County one deep test was drilled by the Sinclair-Prairie Oil and Gas Company, which passed from Deese into Simpson at 8,275 feet and was abandoned at 8,331 feet in Simp-

son green shale, the first encountered in Cooke County. It is noteworthy that the Oklahoma section from Deese to and including some upper Simpson is absent.

On the Preston anticline, northern Grayson County, Olson Brothers Drilling Company *et al.*, Southwest Life Insurance Company No. 1, passed from Cretaceous at the relatively shallow depth of 925 feet into Pennsylvanian rocks (Stanley shale) of Ouachita facies and was abandoned at 5,890 feet in Stringtown or Womble shale of Ordovician age, 110 feet above its contract depth. The Womble of the Ouachita section is considered the approximate equivalent of the Simpson of the Arbuckle section.

A second test by Olson Brothers Drilling Company's Utiger No. 1, drilling below 4,477 feet, is located about 1 mile south of the first. It passed from Cretaceous, with Pennsylvanian absent, into pre-Pennsylvanian at 955 feet and, according to the generally accepted interpretation, encountered the top of the Stringtown or Womble shale of the Ouachita section 3,358 feet higher than in the test farther north, suggesting that these tests are located either on the northern flank of a very sharp fold, since a third test, Simpson-Fell's Wall No. 1, located about 2,200 feet southwest of Utiger No. 1, is 273 feet higher structurally than Utiger, or that the buried trace of the Choctaw thrust fault zone of Oklahoma passes between the two tests and that the higher one is located on the upthrown side of the thrust fault.

On development of production from Strawn sands and the eroded top of Arbuckle limestone in the Altus and Boucher fields, Jackson and Tillman counties, Oklahoma, and later in the year when deep drilling in three tests disclosed the presence of Viola and Simpson in Tillman County, Oklahoma, interest gradually spread westward in Texas to northwestern Wichita, Hardeman, northern Wilbarger, and Foard counties, where considerable work with seismograph, gravity meter, and core drill has been done and is still under way in the hope of outlining structures which are not revealed by surface work in the Permian or by inadequate subsurface data from the few scattered wildcat tests.

PRODUCTIVE SECTION, TEXAS PANHANDLE

Figure 4 shows a general stratigraphic section, Figure 5, a transverse section, and Figure 6, a longitudinal section, all by Rogatz,[5]

[5] Henry Rogatz, "Geology of Texas Panhandle Oil and Gas Field," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 19, No. 8 (August, 1935), pp. 1089–1109.

for the Panhandle oil and gas field, which is situated on the Amarillo uplift, petroleum accumulation being found in the "Panhandle lime" and granite wash of Lower Permian and Upper Pennsylvanian age. In general, gas production is confined to the structurally higher part

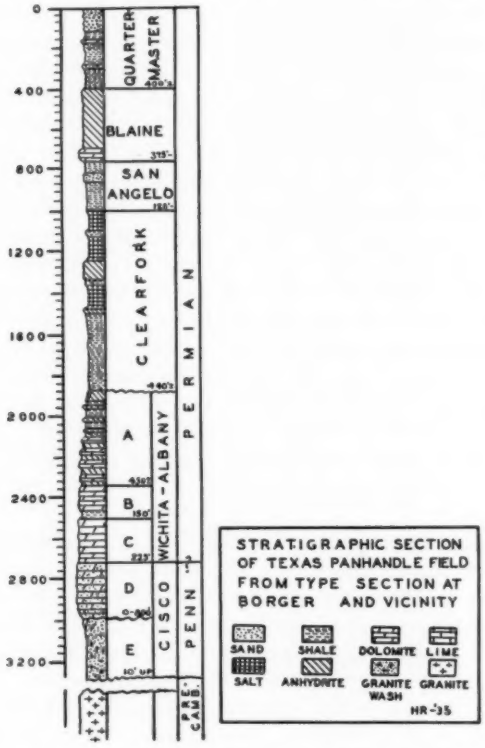


FIG. 4.—Stratigraphic section of Texas Panhandle field from type section at Borger and vicinity. Vertical scale in feet. From Henry Rogatz, "Geology of Texas Panhandle Oil and Gas Field," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 19, No. 8 (August, 1935), Fig. 2, p. 1093.

of the field, and oil production is found lower on the structure, and to date, principally on the northern flank. Water level, the lower limit of production, lies approximately at sea level in both the "Panhandle lime" and the granite wash. As the granite wash lies principally below the "Panhandle lime," granite-wash oil pools lie adjacent

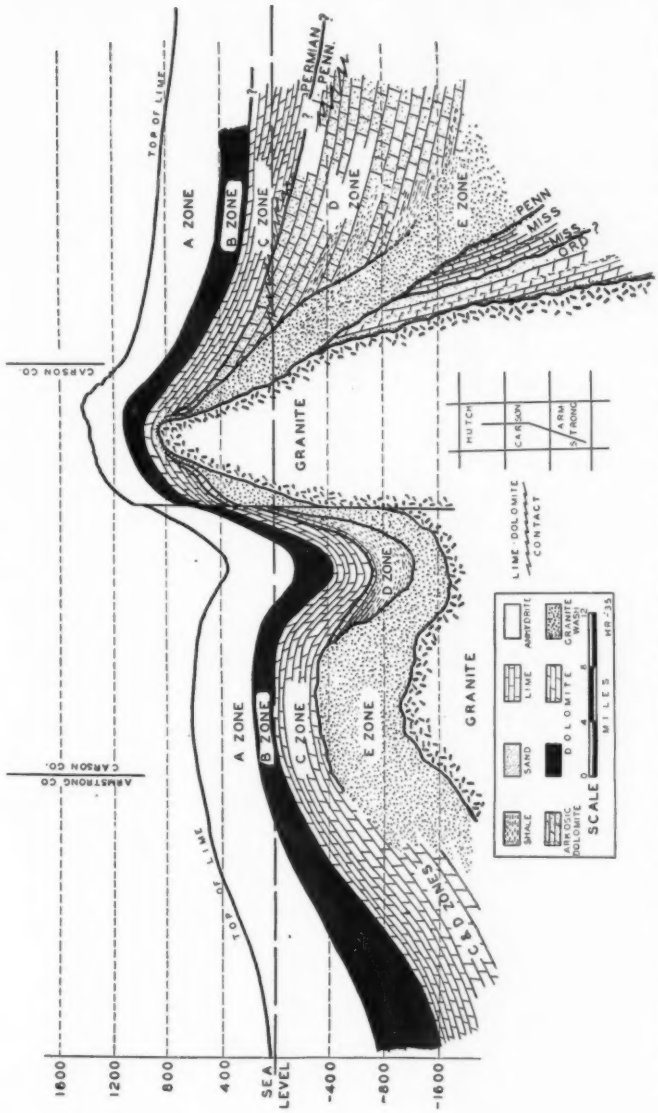


FIG. 5.—Transverse section of Granite ridge, Texas Panhandle. Vertical scale in feet. Permian Red-beds not shown. From Henry Rogatz, "Geology of Texas Panhandle Oil and Gas Field," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 19, No. 8 (August, 1935), Fig. 3, p. 1095.

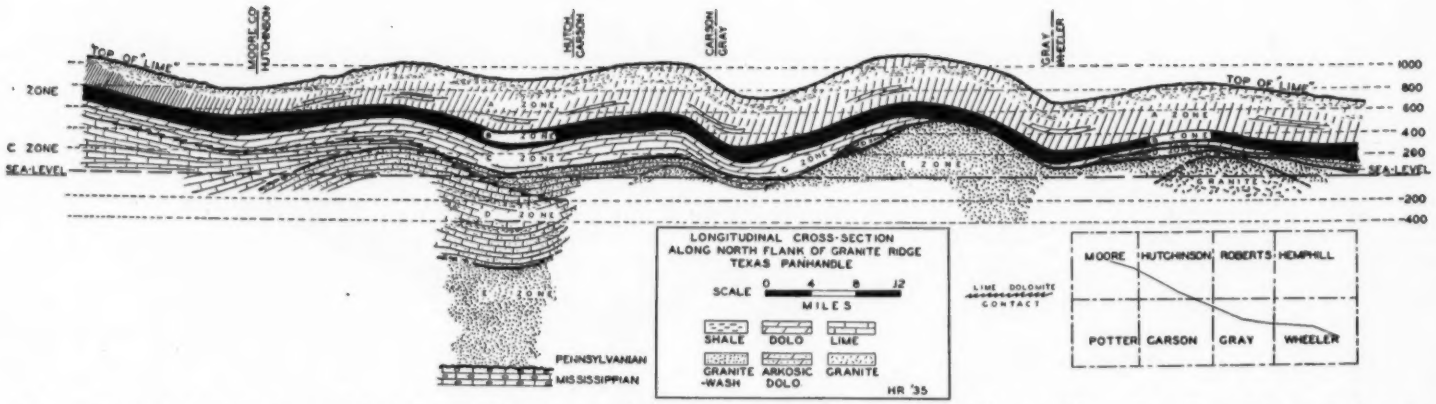


FIG. 6.—Longitudinal section along north flank of Granite ridge, Texas Panhandle. Vertical scale in feet. Permian Red-beds not shown. From Henry Rogatz, "Geology of Texas Panhandle Oil and Gas Field," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 19, No. 8 (August, 1935), Fig. 4, p. 1100.

to the gas area, whereas dolomite ("Panhandle lime") pools lie farther from the crest of the structure.

INTERESTING NEW AREAS DISCOVERED OR FURTHER DEVELOPED DURING PAST YEAR AND IMPORTANT WILDCAT TESTS IN TEXAS PANHANDLE

In Figure 7 the strip of production from the "buff" dolomite formation of the "Panhandle lime" along the northern flank of the Amarillo uplift has been extended northwestward during the year by development in the Stinnett area north of the Canadian River in Hutchinson County, where 10 oil wells have been completed and several tests are drilling.

In Hansford County north of the Panhandle field and two miles south of the Oklahoma Panhandle boundary, Hobbs's Pearson No. 1, was recently completed, with a production of 8 million cubic feet of gas in the "Panhandle lime" at a total depth of 2,864 feet. This well lies between the Hugoton, Kansas, and the Texas Panhandle fields, about 15 miles south of the Guymon, Oklahoma, gas area, and high on the northwestern flank of the Anadarko basin.

On the north flank of the Amarillo uplift in Wheeler County, Phillips Petroleum Company's Porter No. 1, cable-tool test, is drilling below 7,115 feet (minus 4,710 feet). At the present depth the drill has penetrated about 4,000 feet of granite wash with some arkosic gray shales, and is still in that formation. A showing of oil occurred about 750 feet below the top of the granite wash, and another 1,030 feet below the top. It is planned to drill this test to the Ordovician.

PRODUCTION AND DRILLING STATISTICS, TEXAS PANHANDLE

Total production figures for each county to January 1, 1937, and total for the district are shown in Figure 7 and also in Table III. Considerable new drilling and higher oil allowables caused 1936 oil production to exceed 1935 production by slightly less than 1 million barrels. The daily oil allowable is approximately 69,000 barrels and the gas allowable 1,300 million cubic feet.

During 1936, 665 wells were drilled in the Panhandle district, of which 475 were oil wells, 159 gas wells, and 31 dry holes.

GENERAL ACTIVITIES, TEXAS PANHANDLE

The larger part of the new activity in the development of the Panhandle field during 1936 took place in Moore County, where many leases which were taken 10 years ago were nearing their expira-

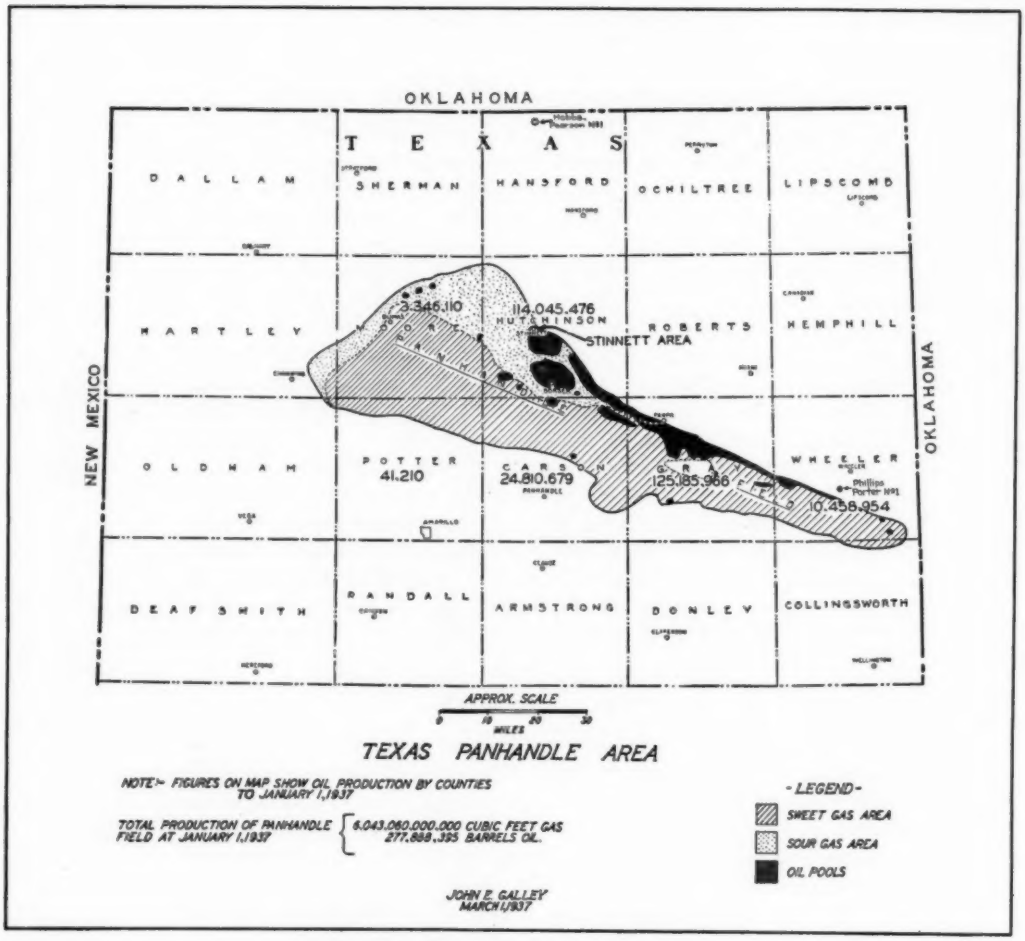


FIG. 7.—Oil and gas fields of Texas Panhandle.

TABLE III

OIL PRODUCTION IN PANHANDLE DISTRICT
(*Figures in Barrels*)

County	*Total to End 1936**	*During 1935†*	*During 1936‡*
Carson	24,810,679	1,774,395	1,951,650
Gray	125,185,966	11,200,522	10,880,900
Hutchinson	114,045,476	4,617,574	5,551,550
Moore	3,346,110	465,915	484,000
Potter	41,210	ooo	ooo
Wheeler	10,458,954	3,480,665	3,607,450
Total	277,888,395	21,539,071	22,475,550

Tests Drilled in Panhandle District During 1936‡

Oil	*Gas*	*Dry*	*Total*
475	159	31	665

* Figures furnished by John E. Galley, who was aided by R. H. W. Hamilton and H. W. McCue in preparing some of the Panhandle statistical data.
† From A.I.M.E. *Bulletin*.
‡ From *Oil Weekly*.

tion dates and had to be renewed or developed in order to be saved. There are four local oil pools of small areal extent in Moore County, but the most important production in the county is that of natural gas. In general, the southern part of the county produces sweet gas and the northeastern part sour gas. By State law and Railroad Commission order, sweet gas may be used only for light and fuel and for transporting from the area by public utility pipe-line companies, and carbon-black plants are permitted to use only sour-gas residue from natural-gasoline plants. The result in 1936 was a great expansion of natural-gasoline and carbon-black industries in Moore County to draw upon the sour-gas reserves.

Sweet-gas production was increased by new wells, and extensions and additions to natural-gas pipe lines to northern markets.

During 1936 there were in continuous operation in the Panhandle field 43 natural-gasoline plants with a total capacity of about 762 million cubic feet per day. Additional carbon-black plants with a total capacity of 150 million cubic feet of gas per day were under construction or contemplated at the end of 1936.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 21, NO. 8 (AUGUST, 1937), PP. 1034-1041, 1 FIG.

DEVELOPMENTS IN WEST TEXAS AND SOUTHEASTERN NEW MEXICO IN 1936[1]

H. P. BYBEE[2] AND BERTE R. HAIGH[3]
Midland and San Angelo, Texas

ABSTRACT

During 1936, nine new pools were opened in West Texas and three in New Mexico. Five producing areas in New Mexico and nearly all fields in Andrews, Ector, Ward, and Winkler counties, Texas, were extended. Although comparatively few wildcats were drilled in 1936, field development was more extensive than in 1935.

A considerable advance in development was made in the combined area of West Texas and Southern New Mexico during 1936. Nine pools classified as new were opened in West Texas and three in New Mexico during the year. Five areas in the New Mexico district and practically all fields in Andrews, Ector, Ward, and Winkler counties of West Texas were extended. Very few wildcats were drilled in either area as compared with 1935, but the field development was much more extensive, due, no doubt, to better market conditions. Many of the wildcats and semi-wildcats listed in the West Texas area were really outpost wells, drilled on trend and ranging from ½ mile to 1 mile ahead of production.

The following tabulation shows the results in statistical form.

PIPE-LINE RUNS FOR WEST TEXAS AND SOUTHEASTERN NEW MEXICO IN BARRELS

	1935	*1936*	*Increase (+) or Decrease (−)*
West Texas	55,207,132	60,373,101	+5,165,969
Southeast New Mexico	19,906,474	26,763,210	+6,856,736
Increase in pipe-line runs 1936 over 1935			+12,022,705

STOCKS IN BARRELS

	1935	*1936*	*Increase (+) or Decrease (−)*
West Texas	16,503,213	14,758,383	−1,744,830
Southeast New Mexico	869,570	985,250	+115,680
Decrease over entire area			−1,629,150

[1] Read before the Association at Los Angeles, March 18, 1937. Manuscript received, May 15, 1937. In this report, "West Texas" is considered that part of the state west of a north-south line through Tom Green County and south of Latitude 34° N.

[2] Geologist, University Lands, Box 1865, University Station, Austin, Texas.

[3] Geologist, University Lands, Box 1663, Midland, Texas.

DRILLING OPERATIONS

	Field Wells	*Wildcats and Semi-Wildcats*	*Dry*	*Producers*	
				Oil	*Gas*
West Texas	1,193	277	137	1,330	3
Southeast New Mexico	534	13	24	516	7
	1,727	290	161	1,846	10

Total wells completed: 2,017 or 94 per cent more than in 1935.

DEVELOPMENT IN DETAIL

NEW FIELDS

LIMESTONE PRODUCTION

TEXAS

Henderson-Walton, Winkler County, 3 miles north of north edge of Hendrick pool.

Discovery well.....Uscan (Henderson) Walton 1
Sec. 9, Blk. 26, Public School Land
Pay depth in feet.....3,020–3,050
Pay horizon.....(Reef material) Hendrick limestone
Initial production in barrels.....1,689 flowing (natural)
Gravity.....29.4°
Discovery well completed.....April, 1936
Number wells in pool.....40 producers
15 drilling

Fields, Cherry-Daughtery, Winkler County, Sec. 3, Blk. 26, Public School land, just south of New Mexico line. Development may prove it to be north extension of Leck pool

Discovery well.....Field, Cherry, and Finley, Daughtery 1
Pay depth.....2,950–3,050
Pay horizon.....Hendrick limestone
Initial production in barrels.....200 flowing (after acid)
Gravity.....33°–35°
Discovery well completed.....December, 1936
Number wells in pool.....2 producers
3 drilling

Hurdle area, Upton County, 3 miles east of Lane-McCamey area, Sec. 19, Blk. 1, Missouri, Kansas, and Texas Railroad survey

Discovery well.....Brewer and Smith (now Merrick), Cordova Union 1
Pay depth.....2,000–2,050
Pay horizon.....McCamey limestone ("Brown lime" at base of White Horse)
Initial production in barrels.....126 pumping (after acid)
Gravity.....27°–29°
Discovery well completed.....December 10, 1936
Number of wells in area.....3

Tubbs area, western Crane County, a new limestone horizon (No. 24 in Fig. 1)

Discovery well.....Humble, Tubb 1
Pay depth.....4,300–4,375
Horizon.....Below Blaine (possibly Clear Fork)
Initial production in barrels.....876 flowing (after shot)
Gravity.....35°–36°
Discovery well completed.....March 18, 1936
Number of wells.....13 producers
5 drilling

Dodson-Carter, Glasscock County, approximately 10 miles southwest of Howard-Glasscock County line pool

Discovery well	Dodson *et al.*, Carter Heirs 1
Pay depth	2,638–2,664
Pay horizon	Blaine
Initial production in barrels	128 oil, plus 120 water
Gravity	
Discovery well completed	October, 1936
Number of wells	1

Seminole pool (No. 37 in Fig. 1), Gaines County, 3 miles northwest of Seminole

Discovery well	Amerada, Averitt 1 (Now called Harry Adams Corp.)
Pay depth	4,996–5,032
Pay horizon	Blaine
Initial production in barrels	200°
Gravity	33.2°
Discovery well completed	December, 1936
Number of wells	1

Kirk area (No. 36 in Fig. 1), Gaines County, 9 miles south of Seminole

Discovery well	Landreth Production Company, Kirk Bros. 1
Pay depth	4,796–4,850
Pay horizon	Blaine
Initial production in barrels	50 pumping After acid and shot
Gravity	26.5°–27°
Discovery well completed	October, 1936
Number of wells	1

Bennett pool (No. 38 in Fig. 1), Yoakum County, 9 miles southeast of Plains

Discovery well	J. C. (Red) Davidson, Bennett 1 (Now Honolulu-Cascade)
Pay depth	5,087–5,264
Pay horizon	Blaine
Initial production in barrels	235 After acid and shot
Gravity	34.6°
Discovery well completed	April, 1936
Number of wells	2 producing

Cascade Duggan, Cochran County, southeastern part of county, League 55, Oldham County, School Land

Discovery well	Honolulu-Cascade, Duggan Bros. 1
Pay depth	5,018–5,068
Pay horizon	Blaine
Initial production in barrels	200 after shot
Gravity	29.8°
Discovery well completed	November, 1936
Number of wells drilled	1

Albaugh-Robinson, Dawson County, northwestern corner of county

Discovery well	Ray Albaugh *et al.*, Robinson 1
Pay depth	4,958–5,038
Pay horizon	Blaine
Initial production in barrels	100
Gravity	34°–35°
Discovery well completed	December, 1936
Number of wells in area	1

NEW MEXICO

Hardy area (No. 9 on map), Sec. 29, T. 21 S., R. 37 E.

Discovery well	Barnsdall, Henry 1
Pay depth	3,701–3,800
Pay horizon	New Mexico correlation: Capitan. Texas correlation: White Horse
Initial production in barrels	225 natural
Gravity	34
Discovery wells completed	March 29, 1936
Number of wells in field	14 producers 4 drilling

Farney area, Sec. 5, T. 23 S., R. 36 E.

Discovery well	Continental, Farney 1
Pay depth	3,750–3,760
Pay horizon	S. A. Hardy
Initial production in barrels	900
Gravity	30°–32°
Discovery well completed	December 25, 1936
Number of wells	February 15, 1937: 3 producers 2 drilling

SAND "PAY"

TEXAS

Keyes pool, Winkler County, between Hendrick and Keystone

Discovery well	Keyes, Cherry *et al.* (now Monday Oil Company), Central State Bank of Abilene 1
Pay depth	2,720–2,827
Pay horizon	Yates sand zone
Initial production in barrels	595 flowing
Gravity of oil	35°
Discovery well completed	March 5, 1936
Number of wells in pool	92 producers Many drilling

This pool now combined with Sayre and Brown-Altman and called Kermit

Hathaway-Estes area, Ward County, northeast corner of Block 34, H.&T.C.; 10 miles north of Grand Falls

In April, 1936, Richardson Oils, Inc., completed their Hathaway No. 1 as a 12 million-foot gas well at 2,275 feet in Yates sand; in August they completed their Hathaway No. 2 at 2,568 feet in Upper Whitehorse sand (Yates zone) with an initial production of 4,515 barrels. After completion of Hathaway No. 2 the Gulf Oil Corporation deepened their Estes No. 1 from 2,575 to 2,950 feet and secured an initial production of 535 barrels after shooting with 240 quarts from 2,595 to 2,680 feet. Following this operation several wells were deepened and several twin wells were drilled. In the combined area are 53 wells producing from 2,450–2,575 feet, 7 wells producing from 2,850–2,950 feet, and 31 wells are drilling. Two were dry and abandoned. The gravity of the oil is 34°–36°.

Dobbs area, Ward County, a small sand area 1 mile northeast of Grand Falls, Sec. 14, Blk. 5, H.&T.C.

Discovery well	Dobbs Oil Company, Bray 1
Pay depth	2,563
Pay horizon	Whitehorse sand
Initial production in barrels	34°–35°
Discovery well completed	February 20, 1936
Number of wells	2 producing 1 drilling

Howard-Glasscock field, on Howard-Glasscock line, Sec. 159, Blk. 29, W.&N.W.

Continental-Group I has developed a considerable production from the Yates horizon near 1,300 feet which is now in this area. On January 1 there were 19 wells producing from this horizon with a combined potential of 7,445 barrels and 6 wells were located or drilling.

NEW MEXICO

Langlie area, Sec. 10, T. 25 S., R. 37 E.

Discovery well	Culbertson and Irwin, Stewart 1
Pay depth	3,275–3,300
Pay horizon	Whitehorse sand
Initial production in barrels	1,644
Gravity	27°–32°
Discovery well completed	May 5, 1936
Number of wells	16 producers and 3 dry holes; 1 on the southeast in Sec. 15, T. 25 S., R. 37 E.; and 2 on the north in Sec. 4, T. 25 S., R. 37 E.

EXTENSIONS

TEXAS

SPECIAL MENTION

Winkler County

Sayre was extended north, south, and east.

Keystone was extended north and west.

Brown and Altman, Keyes and Sayre are combined by the Railroad Commission and called Kermit.

Ward County

Wickett area (No. 10 on Fig. 1) University Block 16. The Eppenauer Drilling Company deepened their University No. 1 from 2,730 to 2,749 feet and increased potential from 85 barrels to 865 barrels. The area has been extended ⅜ mile west; on January 1, 1936, there were 5 wells with 291 barrels potential; on January 1, 1937, 16 wells with 12,660 daily potential, and 5 wells now drilling.

Crane County

The Taylor Hughes area was extended 2 miles west (Sand Hills).

The Gulf Ordovician area now has 2 producers and 3 widely scattered drilling wells.

Waddell-Henderson-Edwards area in Block 23 (No. 25 on Fig. 1) showed considerable development and was extended east.

Upton County

The Lane field was extended in all directions; it is now connected with the McCamey area; Powell Gap was extended south and west.

Ector County

Foster area was extended 3 miles northwest and 1½ miles northeast.

Goldsmith was extended north, south, and east.

The Dunning-Cummins area is really an extension of Goldsmith and the combined area extends to date approximately 11 miles northwest and southeast. The northeast limit is probably defined by the Empire's Cummins 1-A, Landreth's Cowden 1, Landreth's Blakeney 1-B, Landreth's Scharbauer 1 (Devonian-Scharbauer, small well, low). The southwest limit is unknown.

North Cowden was extended south and west.

The Harper area was extended ½ mile west; there are 3 producers and 2 wells drilling.

Many wells were deepened and many inside wells were drilled in the Howard-Glasscock area.

A great deal of interior development was carried on in the Denman area.

Andrews County

The Means area was extended several miles south by many Humble outpost wells.

The Henderson, Parker 1, though not yet completed, will probably produce 8–10 barrels per hour and will constitute a southwest extension to the Fuhrman-Ford area.

Pecos County

The Netterville area, across river from Ward County, was extended south.

Masterson area was extended south and east.

Though the foregoing fields have been given special mention, practically all fields in Andrews, Crane, Ector, Ward, and Winkler counties have been extended and development has been increased by inside wells. Several gasoline plants have been constructed in these West Texas counties and one carbon-black plant is now under construction.

On February 15 there were 395 West Texas drilling activities, with 318 field wells and 77 wildcats or outposts; 352 completions since January 1: 327 oil, 1 gas, and 24 dry and abandoned.

NEW MEXICO

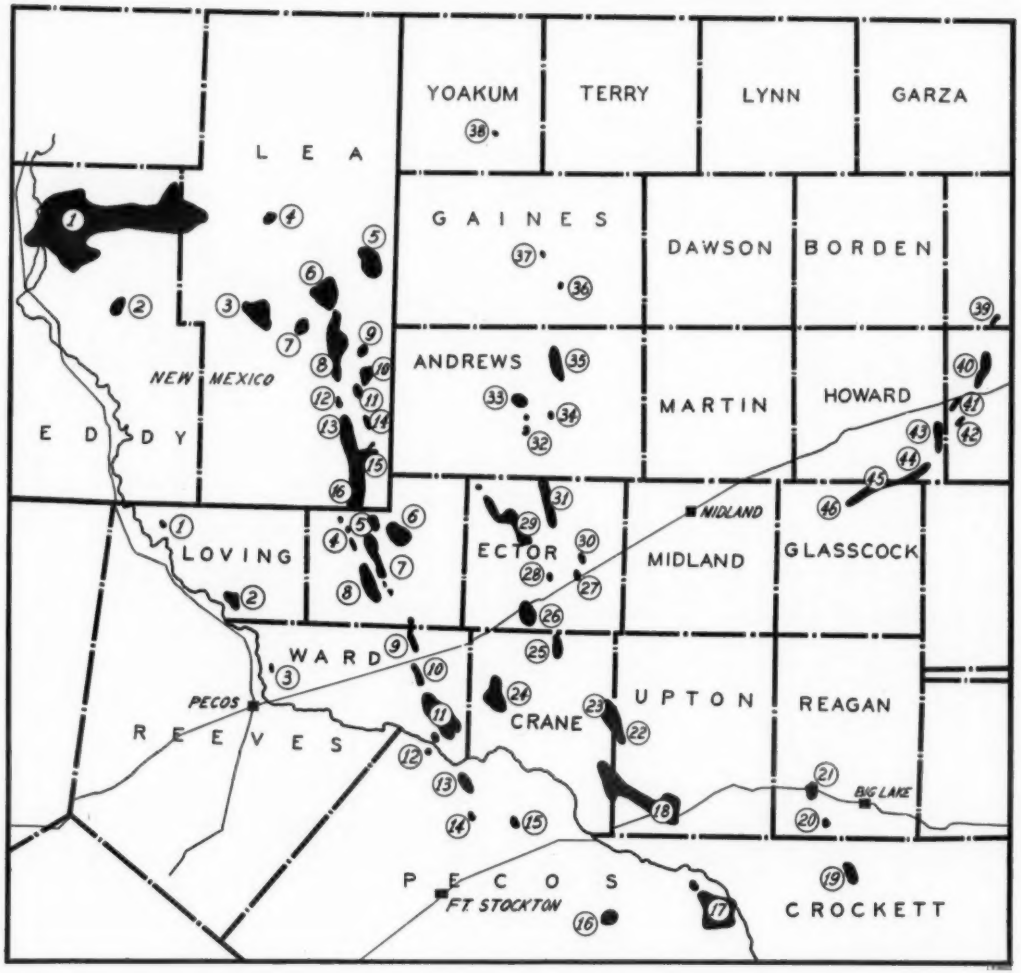
1. The Penrose-Carey field was extended in all directions; it now has 17 producers.

NEW MEXICO

1. Maljamar
2. Getty
3. Lea
4. Vacuum
5. Hobbs
6. Monument
7. Empire
8. Eunice
9. Hardy
10. Penrose
11. Skelly
12. Lynn
13. Cooper
14. Mattix
15. Langlie
16. Jal

WEST TEXAS

1. Mason-Kyle
2. Wheat
3. Monroe
4. Leck
5. Scarborough
6. Keystone
7. Kermit
8. Hendrick
9. O'Brien
10. Wickett
11. So. Ward
12. Netterville
13. Pecos Valley
14. Gregg



WEST TEXAS (Cont'd.)

15. Masterson
16. Taylor-Link
17. Yates
18. McCamey
19. Powell
20. Skelly-Utah
21. Big Lake
22. McElroy
23. Church-Fields
24. Tubbs
25. Waddell
26. Pennfield
27. Addis
28. Harper
29. Goldsmith
30. Foster
31. North Cowden
32. Fuhrman
33. Deep Rock
34. Parker
35. Means
36. Kirk
37. Seminole
38. Bennett
39. No. Westbrook
40. Westbrook
41. Mitchell
42. Iatan
43. Denman
44. Chalk
45. Settles
46. McDowell

FIG. 1.—Location of fields in southeastern New Mexico and West Texas.

2. The Skelly-Harrison was extended east; nine wells are producing.

3. The Mattix area was extended 3 miles south; 13 wells are producers (No. 14 on map).

4. Eunice was extended north and east (No. 8 on map); it was practically defined on the west by increasingly small production and several dry holes.

5. The Cooper area (No. 13 on map) showed no extension. The Byrd-Frost A-1 wells in Sec. 1, T. 25 S., R. 36 E., with initial production of 100 barrels of oil and 1,200 barrels of water, are considered a southwest definition.

6. MacDonald showed no change.

7. Hobbs (No. 5) possibly was defined on the west by Tide Water's State 1 and by Shell's State E-1, Sec. 14, T. 18 S., R. 37 W.

8. Lynch was defined on the southwest by Culbertson and Irwin's J. S. Eaves in Sec. 18, T. 21 S., R. 33 E., dry and abandoned at 3,813 feet.

9. Monument (No. 6) was extended east, southeast, and south, and probably defined on the east by the Gulf's Burke No. 1 in Sec. 28, T. 19 S., R. 37 E., dry and abandoned at 4,020 feet, and by Repollo's Bolden No. 1 in Sec. 10, T. 20 S., R. 37 E., dry and abandoned at 4,257 feet.

This field now (January 1, 1937) has 268 producers, 40 drilling wells, and 2 dry holes.

Two areas that have come into prominence since January 1 should be mentioned.

In Loving County, Texas, the Mason Oil Company, Kyle 2, opened a new Delaware "pay" 18 miles northwest of Wheat field, at 3,901–11 feet. Top of Delaware lime—806; Top of sand—842.

In Lea County, New Mexico, the Brown, Reynolds *et al.*, Parcell-Conoco No. 1 in the center of the NW., SE., Sec. 8, T. 21 S., R. 38 E., encountered production in dolomitic limestone at 4,373 feet, flowing 28° gravity oil by heads early in February, created considerable excitement. The well is located 1 mile west of the Andrews County, Texas, line, 6 miles NE. of the Hardy area, and 12 miles SE. of the Hobbs limestone area.

On February 15 there were 152 wells drilling in southeastern New Mexico: 137 field wells and 15 wildcats; 99 wells completed since January 1: 85 oil, 3 gas, and 11 dry.

FIG. 1.—Location of fields in southeastern New Mexico and West Texas.

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DEVELOPMENTS IN SOUTH TEXAS DISTRICT IN 1936–1937[1]

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ABSTRACT

Several important discoveries were made in the San Antonio district during the past year, probably the most important being the Flour Bluff field south of Corpus Christi. La Blanca in Hidalgo County, La Sal Vieja in Willacy County, and Alta Mesa in Brooks County in the Rio Grande Valley area show prospects of important production in sands to a depth of 8,000 feet. More than twenty pools were discovered and as many new productive sands in old and new pools. It is significant that geophysics is an important factor in the discovery of new fields in the coastal area. The Edwards limestone (Upper Cretaceous) well at Pearsall in Frio County, although not a large well, is of unusual importance inasmuch as it extends production in this formation at least 125 miles and has an influence on an area of probably 10,000 square miles. Among other important discoveries are pools in Aransas, Calhoun, Duval, and Jim Wells counties.

INTRODUCTION

The following is a brief résumé of the major structural features of South Texas (Fig. 1). They consist of the Llano uplift in central Texas, the Balcones fault system, the Sierra Madre Oriental Mountains in northern Mexico, and the resultant Rio Grande embayment, the axis of which approximately parallels the Rio Grande. In the southern part is a salt-dome region of 12,000 square miles in the following counties: Cameron, Willacy, Kenedy, Kleberg, Nueces, Jim Wells, Brooks, Hidalgo, the eastern parts of Starr and Jim Hogg, and the southeastern part of Duval.

The oldest rocks, including the igneous, are found in Mason and Llano counties in the Central Mineral region. Toward the southeast successively younger formations crop out, ending with the Recent formations at the Gulf of Mexico. The oldest oil-producing formations are Cretaceous and are found in the Balcones zone; the youngest are Miocene, at the coast.

1936–1937 DEVELOPMENTS

It is customary to report current developments between one annual meeting of the Association and another; consequently, this re-

[1] Read before the Association at Los Angeles, March 18, 1937. Manuscript received, May 6, 1937. For many years this district has been mistakenly referred to as the Southwest Texas district in spite of the fact that approximately 90 per cent of the area is in the southeastern part of the state. It is undoubtedly more appropriate to call this area South Texas and in this review it is referred to as the South Texas district. Recently the San Antonio Geological Society, a Section of The American Association of Petroleum Geologists, changed its name to the South Texas Geological Society.

[2] Darby Petroleum Corporation.

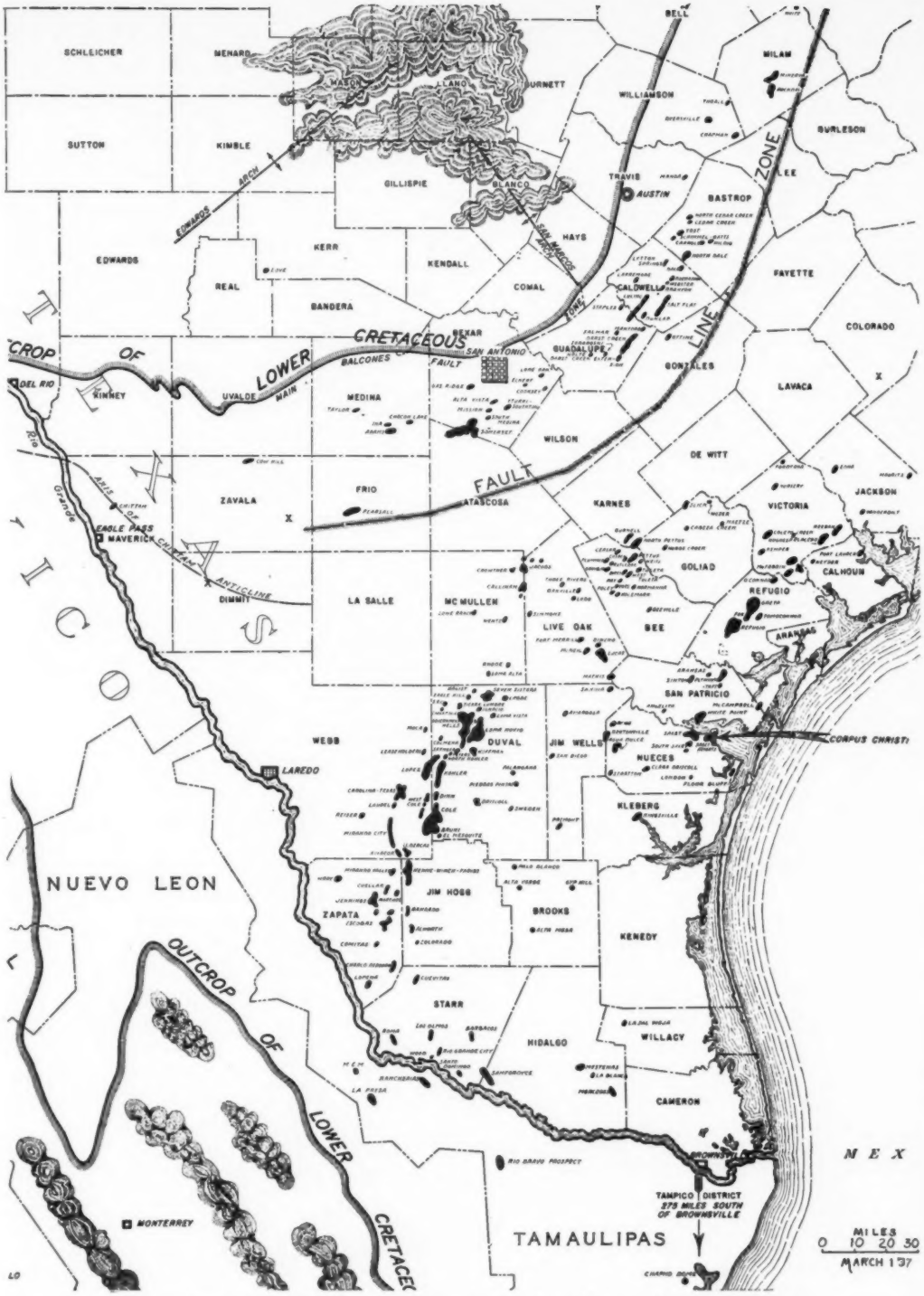

FIG. 1.—Regional map, Rio Grande embayment of southwest Texas and northeast Mexico.

FIG. 2.—Oil and gas fields of the San Antonio district.

view covers the time from March 1, 1936, to March 1, 1937. The A.A.P.G. standard legend is used with the recent discoveries shown in black and the old pools shown with a hatched symbol (Fig. 2).

Twenty-five new pools were discovered during the past year and 29 new productive sands and extensions, making a total of 54 discoveries or a little more than one per week. Of these discoveries, 27 were in the Coastal zone, 21 in the Jackson zone, and 6 in the Fault Line zone.

Pools discovered during the past year were as follows: Flour Bluff, South Agua Dulce, and London in Nueces County; Lamar and McCampbell in Aransas County; Heyser in Calhoun County; Hughes in Victoria County; Maetze and Weser in Goliad County; Voss in Bee County; Rhode in McMullen County; Sweden, Peters, El Mesquite, North Kohler in Duval County; Bentonville and Sandia in Jim Wells County; Alta Mesa and Alta Verde in Brooks County; La Blanca in Hidalgo County; La Sal Vieja in Willacy County; Colorado in Jim Hogg County; Wood in Starr County; Nolte in Guadalupe County.

Additional sand discoveries were in Alta Mesa field in Brooks County; in Heyser field in Calhoun County; in Government Wells, North Kohler, Labbe, Loma Novio, Palangana, and Colemena in Duval County; in Samfordyce in Hidalgo County; in Bentonville and Premont in Jim Wells County; in Clara Driscoll, Saxet, South Agua Dulce in Nueces County; in Taft in San Patricio County; and in Hughes in Victoria County.

FLOUR BLUFF

The most important discovery is the Flour Bluff field in the Coastal zone in Nueces County, a few miles south of Corpus Christi, by Hurlbut *et al.*, with Frio sand in the Oligocene at 6,600 feet. More than 50 feet of saturated oil sand was later cored and in consequence a high per acre yield is anticipated. Twenty-seven wells have been completed to date and 12 are drilling. The program is one well to 20 acres. The discovery is credited to geophysics.

SAXET

Several new productive deep sands have been found in the old Saxet field in Nueces County at 5,800, 6,300, 6,700, and 6,900 feet. The original production was from the 4,000 and 4,400-foot sands. In past years the Saxet pool was considered rather unattractive because of low recovery. Now, however, with the new deeper discoveries, many properties will undoubtedly show a high per acre yield, since

70–100 feet of saturated sand has been logged in several wells. Two deep tests are now planned to go to 8,000 feet. A heavy drilling program was carried on in Saxet during the past year, to the many productive sands.

LONDON

The London field, west of Flour Bluff, was discovered by the Wellington Oil Company in the Miocene at 4,700 feet. A mile and a half southwest of this well is a recent discovery by the Seaboard Oil Company at 6,400 feet, in the Frio. This is strictly a geophysical test and it is the consensus that a large pool may develop.

LAMAR

Considerable importance is attached to the Barnsdall Oil Company's 8,000-foot showing recently on the Lamar geophysical prospect in Aransas County. One well blew out at 8,000 feet and later was completed for 12 barrels a day. A new test is being drilled.

OTHER ACTIVE POOLS

Heyser field, in Calhoun County, is developing good production in sands at 4,600 and 5,400 feet. Other new important discoveries which are being actively developed at the present time are McCampbell in San Patricio County, Sandia and Bentonville in Jim Wells County, Agua Dulce and Clara Driscoll in Nueces County.

LOWER COASTAL

In the Lower Coastal region in the Rio Grande valley area new discoveries are the La Blanca field in the Frio sand at 7,800 feet, opened by the Pantana Oil Company, and La Sal Vieja in Willacy County, where the Shell Petroleum Corporation found production at 7,600 feet, also in the Frio. These are both geophysical prospects and are suspected of being deep-seated salt domes.

BROOKS COUNTY

In Brooks County are the new Alta Verde and Alta Mesa fields, which are old suspected salt-dome prospects. The California Company, now called the Standard of Texas, recently opened the Alta Mesa field in a 3,000-foot sand after drilling an 8,000-foot test which was plugged back and perforated. A second sand at 2,400 feet has since proved productive and three wells are now producing.

SWEDEN

In southeastern Duval County the Sweden field was recently opened by the Hiawatha Oil Company in the Cockfield sand of the

Eocene at 5,800 feet. This is an excellent well of 47° gravity oil and is considered the most important discovery in the Jackson trend during the year. It is suspected that this may also be a deep-seated salt dome, since it is in an area of known salt domes. This is essentially a geophysical discovery.

PEARSALL

In the Pearsall pool in Frio County, which is producing from the Navarro sand and Austin chalk of the Cretaceous, the Amerada Petroleum Corporation found Edwards limestone Cretaceous production at 6,200 feet. This is an extension of Edwards limestone production of about 125 miles southwest from Darst Creek field in Guadalupe County. The well made 100 barrels a day of 37° gravity oil and 200 barrels of salt water. It is now being deepened to 10,000 feet, into the Trinity section, which includes the Glen Rose formation now producing at Rodessa and which was topped at about 6,900 feet.

HEAVIEST PRODUCTION

The heaviest development during the past year occurred in extensions to Loma Novio, Seven Sisters, Lopez, Cole, and Comitas in the Jackson trend, and Saxet, Saxet Heights, Heyser, Placedo, Bentonville, Taft, and Clara Driscoll in the Coastal zone.

GENERAL INFORMATION CONCERNING FUTURE PROSPECTS

Since the South Texas district covers an area of about 60,000 square miles, which is about the size of the state of Michigan, and since the stratigraphic and structural conditions are variable, it is necessary to subdivide it into convenient parts. Six subdivisions of the area are as follows: Coastal zone, Jackson zone, Mount Selman zone, Fault Line zone, Edwards Plateau, and Carrizo Springs district.

COASTAL ZONE

The Coastal zone, of approximately 12,000 square miles, extends about 50 miles back from the Gulf of Mexico and it is the most active area in the district. In the southern part it contains a large area of prospective salt-dome production and is an attractive area for the application of geophysics. It extends a distance of 240 miles, from Jackson County, in the northeastern part, to Cameron County on the Mexican border, and covers all or part of 18 counties. Drilling depths to possibly productive sands in this zone are limited only by the mechanical capacity of machinery.

JACKSON ZONE

The Jackson zone, of about 10,000 square miles, extends from Colorado County on the northeast to Hidalgo and Starr counties on the Mexican border and includes all or parts of 14 counties. The southern part, known as the Mirando district, contains such pools as Government Wells, Pettus, Lopez, and many other prolific shallow productive areas.

MOUNT SELMAN ZONE

This zone is an area about 20 miles in width extending from Burleson and Fayette counties on the northeast to Zapata County on the Rio Grande. It covers an area of about 5,000 square miles and to date does not contain any oil production. The Queen City formation of the Mount Selman Eocene has developed big gas production in the Lopeño field in Zapata County. Some good oil shows have been found in several tests in the Queen City and undoubtedly the Mount Selman zone will receive some additional prospecting during 1937.

FAULT-LINE ZONE

This area parallels the Balcones fault system and covers an area of about 10,000 square miles. The Luling, Darst Creek, Salt Flat, and other pools in this zone produce from the Edwards limestone of the Upper Cretaceous. Austin chalk production is being actively developed at the present time in Caldwell and Guadalupe counties. Little attention has been paid to the Trinity section from northeast Texas to the Mexican border. Included in the Trinity is the prolific Glen Rose section now being actively developed at Rodessa in northeast Texas and Louisiana. Two deep test wells are now being drilled to test this section, one in Guadalupe County and the other in the Pearsall field in Frio County.

EDWARDS PLATEAU

The Edwards Plateau region of about 10,000 square miles is covered by a Cretaceous overlap and with sufficient formations absent to enable the Ordovician to be penetrated at depths of less than 6,000 feet. A number of tests are now being drilled in this vast region, but development is costly and slow. This is the least active area in South Texas.

CARRIZO SPRINGS DISTRICT

This area contains a major geologic feature called the Chittim anticlinal arch, the axis of which trends northwest and southeast through Maverick and Dimmit counties and which is separated from

the Balcones fault zone by a major syncline. This area has no commercial oil production to date, but does have some gas production from the Glen Rose on the Chittim anticline in Maverick County. The Navarro sands, Austin chalk, Edwards limestone, Glen Rose limestone and Trinity sands are all looked upon with favor by the wildcatter. Evidence strongly points to an extensive wildcat campaign in the Carrizo Springs district during the current year.

CONCLUSIONS

South Texas production has not had a long history and unknown territories are numerous. The advance in knowledge of the area in the past 3 years is greater by far than in the previous 10 years. Whereas in past years high recoveries were unknown in South Texas, it is now anticipated by good authority that such pools as Tomoconnor, Flour Bluff, and similar pools will produce from 20,000 to 50,000 barrels per acre from an average depth of 6,000 feet with a well cost of approximately $35,000.00. In the Jackson trend recoveries from Jackson sand in Government Wells, Seven Sisters, Loma Novio, and similar pools are expected to be from 8,000 to 15,000 barrels per acre from an average depth of 2,500 feet, with an average well cost of $10,000.00.

South Texas is merely repeating the history of other producing areas such as Oklahoma, Kansas, and Pennsylvania. With increasing geological knowledge of distinctive subsurface key beds, it is rapidly becoming more convenient to map reasonable subsurface structural interpretations. In consequence of this it may be observed that wildcat wells are now being promoted and drilled by the wildcatter on less acreage than in the past. Furthermore, values have increased enormously mainly in the past two years and principally because of more dependable information. With the assistance of electrical survey records, more careful coring, extensive use of the wire-line core barrel, the gun perforating of casing, and other improved mechanical and geophysical features, more discoveries were made during the past year than in any other year in the history of the South Texas district.

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GULF COASTAL DEVELOPMENTS IN 1936[1]

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ABSTRACT

The Gulf Coastal districts of Texas and Louisiana furnished twenty-one new productive areas during the year 1936. This constitutes a somewhat poorer record than the year 1935, both as to number and character of new fields. None of the Texas discoveries can yet be said to be of major proportions, although initial development on several gives promise of new reserves of considerable magnitude.

Most of the discoveries lie in the deep coastal zone, but two new fields along the Jackson trend and three in the intermediate zone, tend to reinstate these inactive updip areas as profitable fields for further exploration.

Flank development on old domes has been an important activity during the year. The discovery of commercially productive horizons at depths greater than 10,000 feet tends to the belief that there are vast coastal potentialities at depths below those to which present-day exploration has been carried.

The outlook for the Gulf Coast is encouraging. There are indications that the supply of first-class prospects is nearing exhaustion, but untested prospects of a lower rating have been isolated in large numbers and it is believed that these will furnish new reserves comparable to or greater than those already developed.

INTRODUCTION

The writer's review for the year 1935[3] opened with the statement: "The year 1935 represents an outstanding period in the history of Gulf Coast development, both as to the number of new pools uncovered and as to the character of these discoveries." Unfortunately, this statement would have to be somewhat modified in order to apply to the year 1936. It is true that many significant discoveries have been made during 1936, but there is probably none of these that is to be compared with the outstanding discoveries of 1935, nor is there one about which a definite statement may be made at this time as to probable recovery or probable productive extent. During the past year, additional refinements have taken place in the understanding of the geologist and geophysicist of the local problems associated with oil finding. These refinements consist of a better understanding of the capacities of the implements available to his use and of an increased knowledge of the potentialities of the various provinces with which he has to work.

[1] Read before the Association at Los Angeles, March 18, 1937. Manuscript received, April 30, 1937.

[2] Consulting geologist, 813 Second National Bank Building. The writer wishes to acknowledge the assistance of Paul Weaver in the assembling of data and in the preparation of the map.

[3] Orval L. Brace, "Review of Gulf Coastal Developments in 1935." Manuscript read before the Association at Tulsa, March 20, 1937.

At the beginning of 1935, the area along the Jackson or Conroe trend was still regarded with great favor, and numerous localities, isolated mainly by geophysical study, were considered to have excellent chances for production. During the year, many of these favored areas were tested with the drill and the general lack of success brought about a decided change of opinion. At the close of the year 1935, this trend had lost much of its high rating and it was generally recognized that geophysical methods were not as effective there as elsewhere along the coast. During the year 1936, the discovery of two new fields has served somewhat to reinstate this trend as a field for successful future exploration. These discoveries, both of which are located in Polk County, are Segno, in the southeast corner, and Ace, in the southwest part.

Coastward from the Jackson trend, and in reality a part of it, there is an intermediate zone that lies immediately inland from the known occurrences of commercial oil in the Miocene-Oligocene group of sands. Along this trend, numerous prospects were tested during 1936 in the hope of encountering oil in Cockfield sands at depths ranging from 6,500 to 9,000 feet. Three commercial discoveries resulted: the Silsbee field in Hardin County, the Clinton field in Harris County, and the Fairbanks field in Harris County. With these exceptions, none of the several important tests furnished commercial production.

Results in the coastal border area of Miocene-Oligocene production, otherwise referred to here as the deep coastal zone, were more successful, although several of these discoveries were made late in the year and little is yet known as to their capacities. In this zone, there were nine new fields discovered on the Texas side, none of which gives positive evidence at this date of a major rating. In Louisiana, the continuation of this zone furnished seven new fields.

Development during the past year has furnished much valuable information from a structural standpoint. The highly faulted character of the average salt dome has been recognized for several years but improvements in drilling and in well surveying technique have added much to available knowledge during the past 12 months. Discoveries of oil and gas traps of low structural relief, in which faulting plays a prominent part in the distribution of production, are becoming common occurrences and four of the discoveries of the past year seem to be of this type. These are Magnet, Cotton Lake, Amelia, and Bayou Mallet. An increased understanding of these structural peculiarities may be made to explain some of the past failures on outstanding prospects.

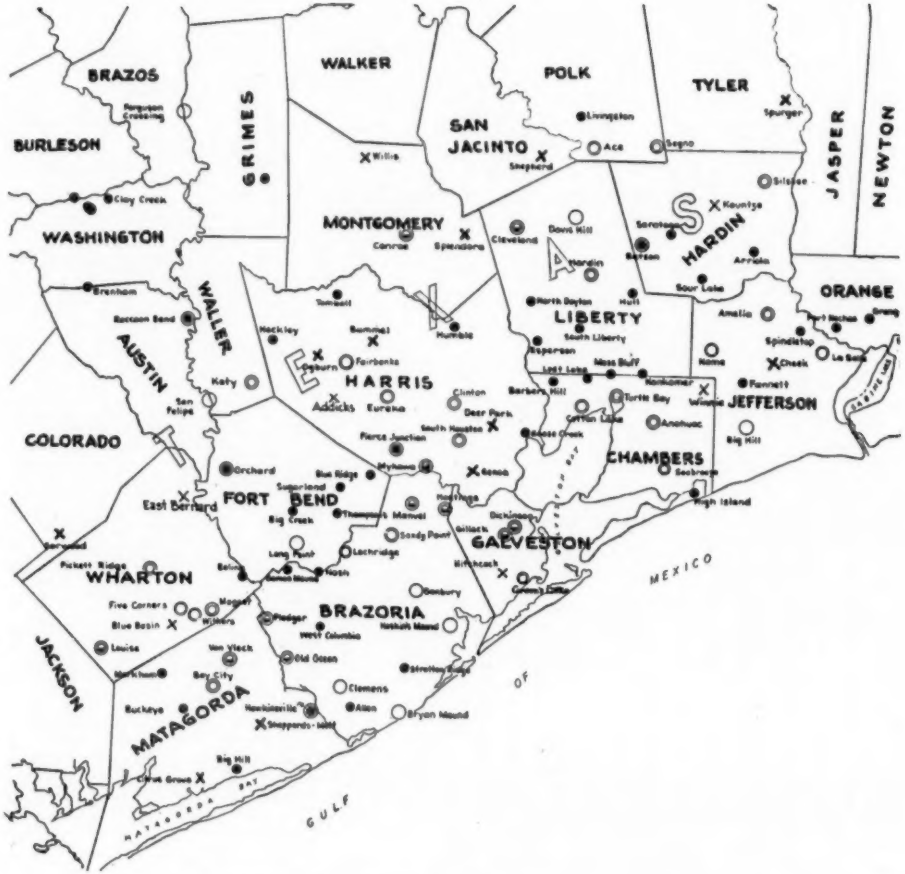

FIG. 1 (left section).—Map showing Gulf Coastal developments during 1936.

FIG. 1 (right section).—Map showing Gulf Coastal developments during 1936.

For the purposes of this discussion, developments are grouped in accordance with the general stratigraphic horizon from which production is anticipated or obtained, following the plan adopted in the review for 1935. In the coastal area, there are five general productive intervals which are, in order from oldest to youngest: Carrizo-Wilcox, Cockfield-Yegua, productive in the Jackson and intermediate zones, and Vicksburg, *Marginulina*-Frio and Miocene, productive in the deep coastal zone. The oldest of these, the Carrizo, produces in a very limited way along the inland margin of the coastal region and the younger horizons become potential successively as the coast is approached.

CARRIZO ZONE

The Carrizo zone has been quiet during the past year. A few scattered wildcat wells have been drilled but nothing of commercial importance or of structural significance has been developed. The two active areas, Beulah, in Trinity County, and Huntington, in Angelina County, reported for 1935, have not developed into commercial fields.

JACKSON TREND

Developments along the Jackson trend were somewhat more successful than during 1935. Additional tests, however, served further to condemn several of the prospects that were at one time considered promising, such as Spurger, Tyler County, Splendora, southeast Montgomery County, and the Willis area, northern Montgomery County. The general Willis area has been intensively prospected throughout a period of years and many tests have shown small quantities of oil and gas. The failure to establish definite structural closure or commercial production would indicate that minor quantities of oil have been trapped in lensing sands in the Cockfield zone, probably in conjunction with structural nosing.

Favorable completions along the Jackson trend during the year, include the following.

Segno.—Segno, in southeast Polk County, is an old torsion-balance prospect. The discovery well, J. K. Dorrance-Wings No. 1, was completed in Cockfield sand at 5,194 feet, on December 24, 1936. It made 600 barrels of 38° gravity oil through a small choke. Previous to discovery, four dry holes had been drilled around the margins of the area.

Ace.—Ace, southwest Polk County, is an old torsion-balance prospect that has been under development for several years. In 1934, a gas well was completed by Dick Schwabb in the Cockfield sand and in May, 1936, the same operator's Kirby Lumber Co. No. 1-A

was completed at 4,805 feet in the same sand for 288 barrels per day. Since this date, several additional small wells and dry holes have been completed and there is now evidence that the area is faulted and that the distribution of production will be erratic.

Along this trend in Louisiana, where the Cheneyville field, Rapides Parish, was discovered during 1935, there has been virtually no activity.

INTERMEDIATE ZONE

Along the coastward margin of the Jackson trend, in the intermediate zone, three discoveries were brought in during the year.

Silsbee.—Silsbee is located in the east-central part of Hardin County. The discovery well, Houston-Republic-Brooks No. 3, was completed in the Cockfield sand at 6,904–82 feet. This well was finished in December, 1936, after a previous test had cratered and burned for a considerable period. There are now four completed wells in the field. Silsbee is an old torsion-balance prospect that was detailed with reflections.

Fairbanks.—Fairbanks is located in Harris County, about 15 miles northwest of Houston. Discovery was made as a result of torsion-balance and reflection work. The discovery well, Amerada & Stanolind-Dopslauf No. 1, was completed in June in Cockfield sands at a depth of 6,820–33 feet. The discovery well has a high gas ratio, but subsequent completions have made excellent oil wells.

Clinton.—Clinton, Harris County, is located on the east edge of the city limits of Houston. Discovery resulted when surface indications, including gas seepage, led to torsion-balance and reflection-seismic exploration. The discovery well, Stanolind-Candelari No. 1, was completed on October 25, 1936, in Cockfield sands at 8,101 feet. The well came in as a gas and distillate well with record pressures in excess of 5,000 pounds. A second test is now drilling.

There were the customary number of disappointments along this trend during the year. Two deep tests were drilled on the Hardin dome, Liberty County, both of which occupy higher structural positions than the lone producer of the field. This well, Frazier-Lynott & Buffam No. 2, has produced approximately 200,000 barrels of oil since completion. Two tests were drilled on the Bammel prospect, Harris County. Both tests encountered encouraging showings of oil in Cockfield sands and each added further evidence to suggest the presence of a small closed structure. An additional test is planned for the Ogburn prospect of Harris County. An additional gas well was completed in the Cockfield on the Eureka prospect, located just beyond the northwest city limits of Houston.

Additional dry holes were drilled along this trend in Harris, Waller, Austin, and Colorado counties that added little to our knowledge of the possibilities of these areas.

DEEP COASTAL ZONE

In the southernmost of the coastal zones, that of Oligocene-Miocene production, results of prospecting for the year were successful in adding nine new productive areas in Texas and seven in Louisiana. Primary geologic studies followed by geophysical mapping, or straight geophysical prospecting, have been responsible for the majority of them.

Magnet.—Magnet, Wharton County, lies east of the Withers field and may prove to be a part of the same structural area. It is a torsion-balance and reflection-seismic prospect. The discovery well, Texas Crusader-Smith No. 1, was completed, making water of questionable origin, and it is now in the process of being worked over. The sand, at 5,563 feet, is of Frio age. Three subsequent tests in the area have been failures so that the potentialities of the field are still uncertain.

Five Corners.—Five Corners, Wharton County, is west of the Withers field. Discovery was made by The Texas Company as a result of the same general geologic and geophysical survey that initially led to the development of Pickett Ridge and Withers pools. The discovery oil well, Texas-Pierce Estate No. 5-B, was completed on January 20, 1937, in Frio sand at a depth of 5,553 feet. Three gas wells had previously been completed in the same sand in this area.

Lockridge.—Lockridge, Brazoria County, was reported as a probable discovery in the review for 1935. The initial well, Gulf-Wilkes & Smith No. 2, was completed in November, 1936, in Frio sand at 6,350–66 feet. Since that date, both Gulf and Shell have completed good commercial wells in this horizon on the southeast flank of the uplift. As previously reported, this is a torsion-balance and seismic prospect.

Sandy Point.—Sandy Point, Brazoria County, is south of, and midway between, Thompsons and Manvel fields. This is an old torsion-balance prospect that was defined by reflections. A dry hole was drilled in the north part of the area in 1934 and the discovery well, De Armand-Fite No. 1, was completed in Frio sands at 6,441–6,453 feet on January 2, 1937. This well makes a small amount of oil with a high gas ratio and the possibilities of the new field are not very promising at the present time.

Green's Lake.—Green's Lake is located on the immediate coast in south Galveston County. The discovery well, Sun-Hughes No. 1,

was drilled to 9,636 feet, but was plugged back to test a favorable shallow sand indicated by Schlumberger survey. It was completed in Plio-Miocene sand at 3,610 feet, producing 288 barrels of oil per day, but has since ceased to produce. A second well is now making a small daily production. Five subsequent tests have been drilled unsuccessfully so that the extent and producing capacity of the area are still unknown. Discovery resulted from seismic exploration centering around an old torsion-balance minimum.

Seabreeze.—Seabreeze, Chambers County, is located about 10 miles southeast of Anahuac field. Favorable torsion-balance and seismic exploration led to development. The discovery well, Sun-Acom No. 1, was the second test drilled on the prospect. It is a wet gasser, producing from Frio sand at 8,190 feet, completed in November, 1936. A second gasser, Sun-White No. 2, 3 miles southwest of Acom No. 1, has since been completed. A third well is now drilling between the two producers.

Three areas that were reported for this zone under the heading "Outstanding Plays Unsuccessful to Date," in the review for 1935, have been brought into production during 1936. These are Nome, Cotton Lake, and LaBelle, none of which has as yet passed the initial development stage.

Nome.—Nome, Jefferson County, has been under development for the past 3 years. It is a poorly defined geophysical prospect, with doubtful closure. There is a mound and other surface evidence. The discovery, Shell-Carpenter No. 1, was the fourth deep test drilled on the prospect. It was completed, July 19, in *Marginulina* sand at 6,058 feet. Five commercial wells have since been completed by the Sun and three by the Shell.

Cotton Lake.—Cotton Lake, Chambers County, is a geophysical prospect that has received one of the most intensive plays of recent years. To date, wells have been drilled throughout a broad area, resulting in several scattered abandoned holes that initially showed prospects of production in thin *Marginulina*-Frio sands, and in seven small oil wells, concentrated in the north part of the area. It is now considered that the erratic distribution of production at Cotton Lake results from the complexly faulted character of an area of low structural relief.

LaBelle.—LaBelle, Jefferson County, has a large gas-distillate well, recently completed. This well, Sun-Hebert & Brousard No. 2, is producing from Frio sands at 8,206–17 feet. As previously reported, this is a surface prospect, checked by geophysics.

Withers, South Bay City, and Amelia.—Withers, in Wharton County, South Bay City, in Matagorda County, and Amelia, Jeffer-

son County, all three of which fields were discovered during the first months of 1936, were reported in detail in the review for 1935.

In coastal Louisiana, as in coastal Texas, the year 1936 failed to uncover new reserves comparable with those found in 1935. There were seven new discoveries for Louisiana during the past year, one of which, Bayou Mallet, was reported in the 1935 review.

Bayou Mallet.—Bayou Mallet, Acadia Parish, is northwest of the Bosco field. It is a reflection-seismic prospect on which two dry holes were drilled prior to the completion of a commercial well. The first producer, Superior of California-Bradley No. 1, was completed in *Marginulina*-Frio sands at a depth of 6,835 feet on March 25, 1936. Since that date, eight wells have been finished: three oil wells, one gas well, and four failures. Production in one well is from the *Heterostegina* zone. Bayou Mallet may be classed as a low-relief structural area with a complex fault pattern.

Cankton.—A second discovery for the Superior of California is Cankton, St. Landry Parish, which lies northeast of the Bosco field and may prove to be a part of the same structural unit. The discovery well, A. Savoy No. 1, was completed on December 23, 1936, in Miocene sands at 5,320 feet for 65 barrels of 36° gravity oil.

Charenton.—Charenton, St. Marys Parish, is southeast of the Jeanerette dome, a sharp syncline, delimited by geophysics, separating the two fields. The presence of large gas seepages and paraffine beds in the area led to geophysical exploration and resulted in favorable gravity and reflection-seismic indications. The discovery well, Mike Hog-Lawes Realty No. 1, was completed on September 6, 1936, in Miocene sands at 7,215 feet. Since discovery, the Pan American Company has acquired control of the property and is directing development. The discovery well made 500 barrels of 34.9° gravity oil per day. A second well has recently been completed, located 1,000 feet southwest of the discovery well.

Valentine.—Valentine, La Fourche Parish, is located in the Mississippi Delta area. This prospect was discovered by Barnsdall in 1934 as a result of torsion-balance and reflection-seismic surveying. The area was initially rendered significant by surface seepages. Barnsdall drilled three wells, two of which, Harang Nos. 1 and 3, encountered salt at 6,970 feet and 6,573 feet, respectively. The Pan American Company took over the property in 1936 and completed its Harang No. 1 in December for 480 barrels of oil in Miocene sands at 6,974 feet. This test is located well out on the east flank of the dome and found production in a section that is missing across the crest of the dome.

South Jennings.—South Jennings, Jefferson Davis Parish, is lo-

cated southeast of the town of Jennings and about 10 miles south of the old Jennings dome. The discovery well, Stanolind-Calcasieu National Bank No. 1, was completed on November 12, in *Marginulina*-Frio sands at 8,648 feet. This is a torsion-balance prospect that was checked by reflections.

Bayou Cocotriz.—Bayou Cocotriz, Terrebonne Parish, is a new discovery located 12 miles southwest of Houma in the Delta area. This is a torsion-balance prospect checked with reflections. The discovery well, the first deep test drilled within a radius of 10 miles, is Shell & Barnsdall-Realty Operators No. B-1. It was completed on February 20, 1937, in Miocene sand, at 9,461–83 feet. It tested 875 barrels of 37° gravity oil per day through ¼-inch choke.

Venice.—Venice dome, Plaquemines Parish, is located near the extreme tip of the Mississippi Delta. This is a prospect discovered by refraction seismograph by the Gulf in 1928 and subsequently worked by torsion balance and reflections. Four wells have been drilled across the crest of the dome, all of which encountered evidence of gas above the cap rock which occurs at 2,200 feet. A deep test now drilling, Tide Water-Manhattan Fruit Co. No. 1, is located on the steep southeast flank. Saturation was found in this well in broken sands of Miocene age, ranging through the section, from 6,429 feet to the present bottom of the hole at 7,235 feet. The well is now being carried deeper after having logged favorable Schlumberger indications in a sand immediately above the present depth.

The outstanding flank development for the year in Louisiana is that of Superior of California on the southwest flank of Jennings dome, Acadia Parish. Prolific production has been found in steeply inclined sands of *Marginulina* age, at 6,300 feet. Drilling at this point has offered evidence of major flank faulting.

In Texas, the Sun Oil Company completed a small well in Miocene sands at 5,178 feet, beneath salt overhang, on the old Hawkinsville dome, Matagorda County. This dome, found as a result of surface and geophysical work and intensively prospected, had been unproductive prior to this completion.

OUTSTANDING PLAYS UNSUCCESSFUL TO DATE

During the year, numerous promising prospects have been drilled with disappointing results. Several of these were reported in the 1935 review. A few of the outstanding examples follow.

Blue Basin.—The Blue Basin area, in Wharton County, adjoins Five Corners field, reported herein, on the southwest. The Pure Oil Company has drilled five dry holes on this second-class geophysical prospect and The Texas Company is now rigging up an additional test.

Winnie.—Winnie, in northeast Chambers County, east of the Anahuac field, is an indefinite geophysical prospect. Several dry holes have been drilled in the area, two of which were completed during 1936.

Cheek.—Cheek, otherwise known as South Cheek, Jefferson County, is a geophysical prospect with some surface geological indications. Several shallow tests and four deep tests have been drilled. The Humble is now drilling a deep test that is reported as checking abnormally high structurally. An active lease play is in progress.

As previously mentioned, several of the areas that were listed under this heading in the review for 1935 have come into the producing column during 1936. The inference may be drawn from this that in areas that are to be classed as second- and third-rate structural prospects, more extensive testing with the drill is normally required before discovery results.

Hester.—In Louisiana, the Shell discovered a new dome at Hester (otherwise called Convent), St. James Parish, located on the Mississippi River above New Orleans, where they encountered salt at 7,492 feet. A second test is now being drilled. This is a promising torsion-balance and reflection prospect.

South Elton.—Another interesting test is being drilled by Stanolind and Amerada on the South Elton prospect, northeast Jefferson Davis Parish. Their Calcasieu National Bank No. 1 blew out while drilling at 9,139 feet. The hole went into Vicksburg at 8,900 feet and cored a good-looking sand, underlain by water at 8,965–8,995 feet. This is the probable source of the gas. This area lies westward along the strike from Tepetate and may possibly be located along the same regional fault which cuts the north edge and is responsible for the trap in the Tepetate field. It was discovered as a result of reflection-seismic work.

Bay Marchand.—On the Bay Marchand prospect (shown on the map as Wisner), La Fourche Parish, Hellas *et al.*, drilling on the north flank of the dome encountered anhydrite at 7,460 feet and salt at 7,480 feet and quit in salt at 8,012 feet. They have now sidetracked and are redrilling the upper hole to test favorable showings in Miocene sands. This prospect was discovered by the Gulf Production Company during its refraction-seismic campaign in 1928. Further geophysical study has added refinements to the original survey.

Bel.—Several other highly regarded prospects have failed to produce after additional tests during 1936. One of these is Bel, southwest Allen Parish. The Humble drilled a well on this surface prospect, early in 1936, that blew out and cratered from an undetermined sand up the hole, while bottomed at 7,770 feet in the Vicksburg. A second

well was drilled to 9,833 feet and abandoned without having encountered anything of an encouraging nature.

Lamar County.—In Mississippi, an outstanding development for the year 1936 was the discovery of a shallow salt mass in northeast Lamar County in a test drilled by the Sun Company. The area in question showed evidence of structure as a result of surface study and in seismic profiles and was subsequently core-drilled. The Sun began a projected 9,000-foot test, but encountered anhydrite at 1,644 feet and salt at 2,524–4,024 feet. A second location has been made. This is the first salt dome found in the state of Mississippi and extends the known region of salt-dome occurrence 135 miles eastward.

EXTENSIONS TO PROVED FIELDS

Extensions to proved fields have constituted one of the outstanding coastal developments of the year. During 1935, Anahuac was extended a distance of 2 miles north and during 1936 an extension of considerable magnitude was accomplished on the east. Oil, at the outer margins of these extension areas, is from the higher *Marginulina* zone, instead of from the normal Frio zone. One of the least anticipated extensions was carried out at Dickinson, Galveston County, where production has recently been found, in the regular pay zone of the field, at a distance of ¾ mile northwest of what had been considered the established field margin. It is possible that this well, Diadem-Way No. 1, has located a separate structural area. Similar extensions have occurred at Hastings, on the north and east flanks of the dome, and at Manvel, Brazoria County, and Conroe, Montgomery County. In the Amelia field, Jefferson County, a new productive area in a higher group of sands has been developed 2 miles north of the original production. This is variously classed as a part of the Amelia dome, separated from the discovery area by a major graben, and as a distinct dome, under the name of West Beaumont.

DEEP DRILLING

Developments on the coast have been carried to new deep levels during the year. The outstanding example is that of Continental-Herbert No. 1, Abbeyville prospect, Vermilion Parish, Louisiana. This well, with a total depth of 12,216 feet, is testing a high-pressure gas sand at 11,795 feet, and additional tests will be made of probable oil sands between this point and the bottom of the hole. This lower productive section is tentatively correlated with the Upper Oligocene zone. In January, 1937, The Texas Company completed a well in sands of Oligocene age at a depth of 10,244 feet in the Lafitte field, Jefferson Parish, Louisiana. It came in for 1,600 barrels per day. On

the Texas coast, Harrison & Abercrombie made a small well in Frio sand early in the year at 9,934 feet in the Old Ocean field of Brazoria County, and a second well has just been completed in Frio sand for 13 barrels per hour, at 10,263–93 feet in the same area. Hammond *et al.* completed the discovery well of the South Bay City field, in Matagorda County, for 625 barrels per day at a depth of 9,361 feet. It is generally recognized that coastal domes have vast future possibilities at greater depths than those that have been explored.

IMPORTANT AREAS UNDER EXPLORATION

There has been no great change in the centers of greatest exploratory activity in comparison with those designated for 1935. In the review for that year it was stated that on the Texas and Louisiana Gulf Coast, as elsewhere, the center of most intense activity tends to move from one locality to another in the wake of successful exploration. During that year, activity was greatest for Wharton, Matagorda, Brazoria, Galveston, Chambers, and Jefferson counties, and this statement holds true for the year 1936. There has been some increase in activity in the intermediate zone, due to the discovery of three new fields. Of the counties listed, Wharton has probably been the most active.

In Louisiana, interest centers mainly in the Mississippi Delta area and in the swampy border lands that lie adjacent to the coast. In addition to the search for new domes, there has been a decided increase in the activity around the flanks of old domes.

FUTURE RESERVES

It is generally recognized that prospects that are to be regarded as first class, under the present classification, have mainly been isolated in the Gulf Coast region. Structural units of second and third class, however, are still available in large numbers and it is upon this type of prospect that the industry must depend for the greater part of its future coastal reserves.

The use of the terms first, second, and third class, must be regarded as a purely arbitrary rating. Assuming that the data upon which classification is based are reliable, then the fact that a prospect is third class should be an indication that the difficulties attending discovery may be greater than in a first-class prospect, but not necessarily that the ultimate potentialities of the prospect are any less promising. This trend toward a preponderance, in the future discovery column, of structural units other than first class, has been well illustrated during the past year. New fields such as Magnet, Fairbanks, Sandy Point, Green's Lake, Cotton Lake, and Amelia are distinctly of this category.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
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DEVELOPMENTS IN NORTHEAST TEXAS DISTRICT IN 1936[1]

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ABSTRACT

During 1936, 77 exploratory wells were drilled in this district, discovering two oil fields, Talco and Sulphur Bluff, and three gas-distillate fields. The new reserves added by the extension of the Rodessa field into Cass County, Texas, and the discovery of Talco and Sulphur Bluff fields did not quite equal the yearly production from this district.

The northeast Texas district (Fig. 1) comprises the 44 counties in the northeast corner of the state. It is bounded on the north by the states of Oklahoma and Arkansas and on the east by the states of Arkansas and Louisiana. It includes, and extends beyond the borders of, what is commonly called the East Texas basin. Within its borders are located several important oil and gas fields; namely, East Texas, Van, Rodessa, Talco, Cayuga, Long Lake, Sulphur Bluff, Mexia, Powell, Bethany, and Waskom.

During 1936, approximately 160 million barrels of new oil reserves and three gas-distillate fields were added to the district. This area produced approximately 180 million barrels of oil and 16,500 million cubic feet of gas. During this period, 77 exploratory wells were drilled, which resulted in the discovery of two oil fields, Talco and Sulphur Bluff, and three gas-distillate fields. This exploratory drilling also condemned two promising structures.

Talco.—The Talco field, Titus and Franklin counties, was discovered in March, 1936, by Housh, Thompson, *et al.* The discovery well was described in the review of recent developments in 1935.[3] However, since the field has been extended by recent drilling, it is necessary to class it with other major oil fields of the district. Talco is a fault structure of the Mexia-Powell type, discovered by surface geology and checked with core-drill information. This structure had been tested dry in the Woodbine section of the Upper Cretaceous.

[1] Read before the Association at Los Angeles, March 19, 1937. Manuscript received, April 17, 1937.

[2] Sun Oil Company.

[3] Wallace Ralston, "Development and Production, East Texas District," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 20, No. 7 (July, 1936), pp. 975–78.
E. A. Wendlandt, "Talco Field, Titus and Franklin Counties, Texas," *ibid.*, pp. 978–79.

RELATIVE POSITION OF OIL & GAS FIELDS
New fields or new productive area in old fields
Partially developed fields
Old fields
Gas fields
Gas-distillate discoveries
Important deep tests X
OKLA.
ARK.
LA.
FANNIN
LAMAR
RED RIVER
BOWIE
DELTA
COLLIN
HUNT
SULPHUR BLUFF
HOPKINS
TALCO
TITUS
FRANKLIN
MORRIS
CASS
RODESSA
CAMP
ROCKWALL
RAINS
WOOD
UPSHUR
MARION
DALLAS
KAUFMAN
VAN ZANDT
VAN
HARRISON
SMITH
EAST TEXAS
ELLIS
HENDERSON
RUSK
PANOLA
NAVARRO
POWELL
CAYUGA
BOGGY CREEK
HILL
ANDERSON
LONG LAKE
CHEROKEE
RUSK
SHELBY
SHELBYVILLE
FREESTONE
MEXIA
CAMP HILL
NACOGDOCHES
McLENNAN
LIMESTONE
SOUTH BOSQUE
SATIN
GRAPELAND
HOUSTON
CHIRENO
SAN AUGUSTINE
SABINE
FALLS
LEON
ANGELINA
ROBERTSON
KITTRELL

FIG. 1

This is the first commercial production, from the Paluxy formation, in the state of Texas. To January 1, 1937, 177 oil wells and 13 dry holes had been completed. Approximately 40 per cent of the wells have been completed as flowing wells, the others being pumpers. Very little gas is present, and it is believed that there will be sufficient water drive to flush the oil from the sand.

Sulphur Bluff.—The discovery well of the Sulphur Bluff field was drilled by the Hager, Luce, and Russ Petroleum Company, on the J. E. Worsham tract, near the small town of Sulphur Bluff, in north-central Hopkins County. It was completed in August, as a pumping well, making 530 barrels of oil per day from the Paluxy sand, at a total depth of 4,500 feet. This field is a faulted structure similar to Talco and was located by surface geology several years ago. Several Woodbine tests were drilled, which gave good subsurface control for accurately locating the fault. Due to the steep dip of the producing horizon, it is estimated that the producing area will be smaller than at Talco. The proved area is estimated to be about 1,500 acres. The oil produced at Sulphur Bluff is about 22° gravity, similar to that produced at Talco. To January 1, 1937, only 12 wells had been completed.

E. G. Thompson,[4] co-discoverer of the Talco field, has prepared a paper on this fault zone, with special references to the Talco field. He describes the geology and history of this area.

Rodessa.—The first oil well in the Texas part of the Rodessa field was completed in Cass County in December, 1935. Since that time it has been proved that the larger part of the field lies in the state of Texas. Structurally this field is related to a northeast and southwest trending fault, extending approximately 15 miles across the north flank of the Sabine uplift. It is only a short distance north of the old Caddo field. The fault was located by the use of logs of the wildcat wells drilled during the development of the Caddo field. This subsurface work was later checked by detail geophysical work. The crest of the structure, which is on the north or upthrown side, produces gas; the flanks produce oil. Wells located on the border between the oil and gas areas have very high gas-oil ratios. From some of the wells in the Louisiana side of the field ratios have been reported as high as 120,000 to 1. This field is producing from the lower Glen Rose of the Lower Cretaceous.

The extension of the Rodessa field into Cass County, Texas, and

[4] E. G. Thompson, "Fault System of Northeast Texas with Emphasis on the Talco Structure as a Type." Manuscript read before the Association at Los Angeles, March 18, 1937.

the discovery of oil in the Paluxy section at Talco and Sulphur Bluff, open a large area for new exploration. Several known structures in this area have been proved dry in the Woodbine section, including Talco and Sulphur Bluff. Since production has been obtained from the Lower Cretaceous on two of these structures, hope is revived that others may produce from deeper horizons.

Grapeland.—Another important discovery for the district was the gas-distillate well completed in July, 1936, near the town of Grapeland, in north-central Houston County. This well, drilled on the J. E. Bean tract, by Ellison, McBride, Haberle, and Thornton, was completed in the Woodbine sand at a total depth of 6,037 feet. Initial tests showed the well to be capable of producing at least 50 million cubic feet of gas and a large amount of distillate. This discovery is very important, as it extends the area of possible Woodbine production about 15 miles southeast of any previous production from this formation. At the present time we believe this to be an anticlinal structure. It was located by surface work and later checked by various geophysical methods.

Shelbyville and Carthage.—The two other gas-distillate discoveries are located on the Sabine uplift, one of them being in the northeast corner of Shelby County, and the other about 6 miles east of the town of Carthage, Panola County. The well in Shelby County was drilled by Stebbinger and others on the Pickering Lumber Company land. It was completed as a small gas well making distillate from the Glen Rose formation of the Lower Cretaceous. The well near Carthage was drilled by A. C. Glassell on the Frost Lumber Company land. It was completed in the lower Glen Rose as a small gas well making considerable distillate. These wells were probably located by both subsurface and geophysical methods. Very few structures on the Sabine uplift have been located by detail surface work, as the Wilcox formation, of Eocene age, is the surface material exposed in most of this area. This formation is very difficult to divide into accurate stratigraphic units on which to map surface structures.

These gas-distillate discoveries may prove to be substantial oil-producing fields, but as yet there has not been sufficient development to predict their extent and economic importance.

Cayuga.—In the Cayuga field, Henderson and Cayuga counties, the Tide Water Oil Company and the Seaboard Oil Corporation drilled their second Trinity test about 2 miles southwest of the first test, which was described in last year's review of developments.[5] This test was completed at a total depth of 7,570 feet in the lower Glen

[5] Wallace Ralston, *op. cit.*, p. 977.

Rose of the Lower Cretaceous. The well is approximately 160 feet lower structurally than their first well. On a 24-hour test, it flowed 443 barrels of distillate and 15,600,000 cubic feet of gas.

The East Texas field is now drilled to a density of 1 well to 5.85 acres. Approximately 4,000 productive acres were added to this field during 1936. All of the area added is on the edges of the field.

The Long Lake and Cayuga fields were extended short distances during the past year. At present the Tide Water Oil Company is drilling a Trinity test in the Long Lake field.

The other fields in the district were extremely quiet, very few wells being drilled and no new horizons being added.

The most important leasing activity has been on the Sabine uplift and along the Mexia-Powell fault zone.

The Superior Oil Company is drilling a well on the Quinlan fault in Hunt County. This well, apparently, is dry in both the Upper and Lower Cretaceous formations. The Quinlan fault was one of the promising areas along the Mexia-Powell-Talco trend. This well encountered a non-marine section below the middle Glen Rose, or anhydrite section.

The Pure Oil Company drilled a well on the Mount Enterprise fault located in south-central Rusk County. This well penetrated the lower Glen Rose section and at least 300 feet of the Travis Peak section. The section below the anhydrite zone, middle Glen Rose, did not show very good porosity, and the Travis Peak section was found to be composed of very hard, fine-grained sands and red beds.

Several important exploratory wells are to be drilled in this district during the coming year, so that by the end of 1937 we should have a better idea of the Lower Cretaceous section and its economic importance.

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DEVELOPMENTS IN ARKANSAS-LOUISIANA-TEXAS AREA, 1936–1937[1]

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ABSTRACT

The Arkansas-Louisiana-Texas region has supplied five new areas of oil production, one new area of distillate production, and six new areas of rich gas production in the year of 1936. The Rodessa field was extended approximately 10 miles southwest, making the present total length of the field 16 miles through Louisiana and Texas. The average width of Rodessa oil and gas production is 2½ miles, with the oil production occupying an average of 1 mile of this width.

INTRODUCTION

In 1936 there was more active oil and gas development in northern Louisiana, northeastern Texas, and southern Arkansas than in any year in the past decade. This development is closely related to the Sabine uplift and the areas of tensional faulting adjacent to it. From the standpoint of the oil and gas industry, this region added more to its economic importance last year than in any year since the discovery of the Haynesville field. Deeper drilling into lower Comanche sections in Louisiana and East Texas, and into undetermined Lower Mesozoic formations and salt in Arkansas, have furnished contributions to geological knowledge and invaluable data for the stratigraphic record.

The discovery of prolific oil as well as gas reservoirs in the oölitic limestones and sandstones of the lower Glen Rose, the development of commercial distillate production in the lower Marine section of the Trinity, and the development of oil and gas production in the Smackover limestone at Smackover, are probably the important events of the Arkansas-Louisiana-Texas region in 1936.

Important extensions and discoveries of deeper production in existing fields, with the discoveries of oil and gas areas, are summarized in the following paragraphs.

RODESSA EXTENSION

The extension of the Rodessa oil and gas field into Cass and Marion counties, Texas, is probably of first importance from an economic standpoint. This lower Glen Rose production, which comes

[1] Presented by title before the Association at Los Angeles, March 18, 1937. Manuscript received, June 5, 1937.

[2] Phillips Petroleum Company.

from oölitic and coquina limestones 30–350 feet below an anhydrite zone of broad extent and fairly uniform thickness, has been extended approximately 10 miles southwest from the Louisiana line into Cass County, Texas. As is generally known, this production is controlled by a northeast-southwest trending fault of 500–600 feet displacement. An outpost well, just north of Jefferson, Texas, and approximately 14 miles southwest from present production, may prove to be an important extension into Marion County.

To February 1, 1937, the Cass County, Texas, side of the field had produced 4,324,886 barrels of oil, while the Louisiana side had produced 22,100,346 barrels, making a total for the entire field of 26,425,231 barrels. This has come from 348 wells in Caddo Parish, Louisiana, and 203 wells in Cass County, Texas. The daily average production of the field is now 87,554 barrels. The largest part of this production is coming from the Young horizon, which is 325 feet below the anhydrite zone previously mentioned. Other productive oil and gas horizons are the Hill sand, Gloyd oölitic limestone, and Dees sands and oölitic limestone. All of these horizons contain oil on some part of the structure.

DISCOVERY OF LOWER TRINITY MARINE PRODUCTION AT COTTON VALLEY, LOUISIANA

Due to the deeper drilling campaign in the Arkansas-Louisiana-Texas region, the old Cotton Valley field in Webster Parish, Louisiana, has again come into prominence by reason of the Ohio Oil Company's discovery of a rich distillate-bearing horizon in the lower Marine sands of the Trinity at 8,100-8,400 feet. The production is coming from a series of sand bodies in the lower Trinity Marine section, approximately 2,500 feet below the base of the Glen Rose, and is the deepest production in northern Louisiana. This 8,100-foot horizon has produced 23,032 barrels of white distillate from three wells since the middle of January, with 10–15 million cubic feet of gas per day.

The deep drilling at Cotton Valley has also discovered oil in the top of the Travis Peak formation at 5,500 feet. This has been somewhat disappointing because of the lenticularity of this non-marine section. The Ohio Oil Company's Holloway No. 6, lone oil producer in the Travis Peak, has, however, produced 102,368 barrels of oil to date.

DEEPENING IN SLIGO GAS FIELD, LOUISIANA

In the Sligo gas field of Bossier Parish, Louisiana, deeper drilling has found new oil and gas production in the lower part of the lower

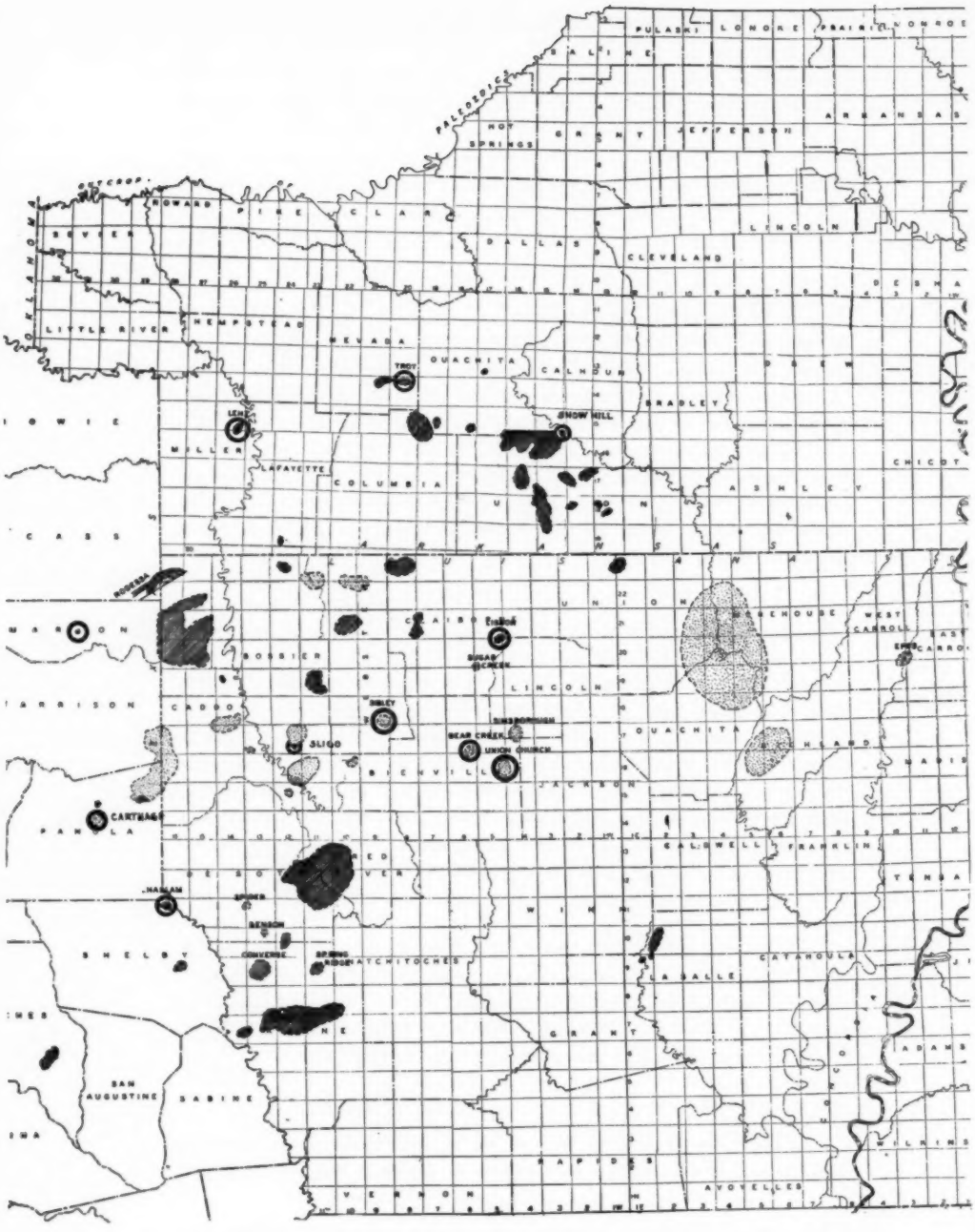

FIG. 1.—Outline map of Arkansas-Louisiana-Texas region. Location of recent discoveries of oil and gas shown in heavy circles. Shaded areas, oil. Stippled areas, gas.

Glen Rose and the top of the Travis Peak from 5,100 to 5,500 feet. Three oil wells have been completed in the so-called "Pettit" zone, which is approximately 900 feet below the base of the anhydrite section. From October 14, 1936, to January 1, 1937, 15,500 barrels of oil have been produced from two of the wells mentioned. Besides the oil discovered here, further important gas reserves have been found in the lower Glen Rose and Travis Peak.

DEEPENING IN SUGAR CREEK GAS FIELD, LOUISIANA

The Sugar Creek field in Claiborne Parish, Louisiana, was another site of deepening activity in 1936. Three wells were drilled into the Travis Peak and one of these continued down to the lower Trinity Marine sands to a total depth of 8,616 feet. All three of these wells were completed as large gas-distillate producers from a petroliferous zone, including the lowermost lower Glen Rose and the top of the Travis Peak formation. The producing horizon includes oölitic limestones and sandstones. In 1936, the Sugar Creek field produced 5 billion, 500 million cubic feet of rich gas.

DISCOVERY OF OIL IN LISBON AREA, LOUISIANA

In the Lisbon area of Claiborne Parish, Louisiana, the discovery of oil by E. T. Oakes on the Patton Estate, during the latter part of last December, has caused added interest in the deeper oil possibilities in the Glen Rose. The production was found at 5,379 feet in a coquina limestone of lowermost lower Glen Rose. This is the first commercial oil found in the Glen Rose east of the Sligo production in Bossier Parish. Four tests are drilling in the immediate vicinity of the discovery, and the productive area will doubtless be determined this year. The discovery well is producing 125–180 barrels per day of 33.4° gravity oil.

DISCOVERY OF GAS IN UNION CHURCH AREA, BIENVILLE PARISH, LOUISIANA

On April 4, 1936, a new gas field was opened by Lide and Greer in T. 16 N., R. 5 W., Bienville Parish, Louisiana. The discovery well is producing from the lower Glen Rose (Hill sand equivalent) at 5,863 feet. Recently, a second well has been completed in the top of the Travis Peak at 7,160 feet. These wells have high initial volumes, ranging from 30 to 60 million cubic feet.

DISCOVERY OF GAS PRODUCTION AT SIBLEY, LOUISIANA

On May 22, 1936, gas production was discovered by J. P. Evans *et al.*, near the town of Sibley, Webster Parish, Louisiana. The gas is

coming from sands and oölitic limestone at 5,560–5,650 feet in the upper part of the lower Glen Rose. The wells have large initial volume with considerable distillate.

DISCOVERY OF GAS IN LOWER GLEN ROSE AT CONVERSE FIELD, LOUISIANA

In the old Converse field, Sabine Parish, Louisiana, F. C. Cox *et al.* found gas production in an oölitic limestone horizon of the lower Glen Rose at 5,500 feet. This discovery was made in July but the operators have not been able to complete the discovery well. A second test has been commenced to the same horizon.

DISCOVERY OF GAS FOUR MILES EAST OF CARTHAGE, TEXAS

On September 1, 1936, A. C. Glassell *et al.* opened a new gas area on the Frost Lumber Company land northeast of Carthage, Texas. This gas is being produced from an oölitic zone near the base of the lower Glen Rose, equivalent to the Pettit zone of the Sligo field in Louisiana. The field has three gas wells to date, with a fourth drilling.

DISCOVERY OF GAS IN HASLAM AREA, SHELBY COUNTY, TEXAS

On September 8, 1936, a new Glen Rose gas area was discovered by Stebbinger *et al.*, on the Pickering Lumber Company land, just east of Logansport, Louisiana. The gas is coming from 5,029 feet in the lower Glen Rose. Only one well has been completed but a second test is now drilling.

DISCOVERY OF DEEP OIL AND GAS AT SNOW HILL, ARKANSAS

In the Snow Hill area, at the north edge of the old Smackover field, the Philips Petroleum Company opened new production in the so-called Smackover limestone at a depth of 4,900 feet. This productive limestone section is of undetermined age at present, although it is thought to be lower than Trinity and younger than Paleozoic. The limestone is 700 feet in thickness with 100 feet of porous oölitic section at the top which contains oil, gas, and salt water. Under the Smackover limestone, 30–50 feet of red shale and sandstone occur above a salt section of varying thickness.

To January 1, 1937, the Snow Hill Smackover limestone production showed a total of 58,034 barrels of oil and distillate from five wells.

TROY FIELD, NEVADA COUNTY, ARKANSAS

The discovery of oil in the Nacatoch and Tokio formations near Troy, Arkansas, by Benedum and Trees, has called attention to the fact

that operators may be overlooking Upper Cretaceous possibilities in their intense search for Trinity production. The Troy field, to date, has five completed oil wells and one gas well, three producing from the Nacatoch sands at 1,200–1,250 feet and three from the Tokio sands at 2,150–2,250 feet. The oil from the Nacatoch is 14° and the Tokio 21° gravity. Most of the wells are producing considerable salt water with the oil, but the field has a daily average at this time of 900 barrels of oil per day on the pump.

DISCOVERY OF GLEN ROSE PRODUCTION NORTHEAST OF OLD GARLAND CITY OIL FIELD, MILLER COUNTY, ARKANSAS[3]

Three miles northeast of the old Garland City field, in Miller County, Arkansas, C. V. Lenz and associates found oil production in the lower Glen Rose at 4,210 feet, on December 2, 1936. The producing horizon is a sand and is approximately 240 feet below the anhydrite section. The well is now making 80 barrels per day on the pump.

[3] Since this paper was written the Lion Oil Company has opened a new oil pool just south of Schuler, Union County, Arkansas. The production is coming from 1,500 feet below the top of the Travis Peak formation and is found in lenticular sands at a depth of 5,500 feet.

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RUSSIAN OIL FIELDS IN 1936[1]

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ABSTRACT

The preparation for wildcatting in the U.S.S.R. during 1934 and 1935, which was, if anything, entirely too thorough in its minute details, resulted in several major discoveries during 1936. At the same time it is believed that the industry has progressed sufficiently to adopt American methods of wildcatting with steam and Diesel power, involving a minimum of capital investment in permanent installations like power lines, machine shops, living quarters, *et cetera*, thus promising accelerated exploration during the coming years.

The Caucasus supplied all of the major discoveries during 1936. This was due to the clearer understanding of stratigraphy and structural conditions of the areas, to the accessibility of the region to the available facilities of the oil industry, and to the forced exploration of individual major structural features by as many as ten to fifteen tests. The outstanding discoveries of the year were made on the shores of the Caspian Sea in Dagestan Province near Makhach-Kala, about half-way between Grozny and Baku. Izberbash proved to be the most important new field, with initial productions ranging above 4,000 barrels per day of 40° gravity crude oil (0.15 per cent sulphur) from 5,400 to 5,900 feet in the Chokrak sands of the Miocene. Izberbash is a large faulted anticline with major closures on both sides of the fault. The Achi-Su field near Izberbash was discovered also in 1936, and though its initial yields are small, 70-200 barrels per day, the depth is very shallow, about 2,400 feet, and the structure is of large areal extent. On the Apsheron Peninsula in Puta district, a notable discovery was made at Shangar. The Kergez and Kizil-Tepe fields, discovered prior to 1936, were actively developed and extended. In older fields of the Baku district, greater penetration into Pliocene oil measures of deeper oil fields uncovered additional reserves of major magnitude. South of the Apsheron Peninsula a major field was discovered at Pirsagat in 1936, and a second producer was completed in October, yielding 2,500 barrels from a depth of 4,500 feet. In the Northern Caucasus near the Black and Azoff seas, several small fields were discovered in the Maikop and Kuban districts, the outstanding ones being Asphalt Mountain and Kutaiski in Maikop and Adagum and Keslerovo in Kuban. In the Ural Permian basin, considerable progress was made in exploration technique, and the basin is assuming the proportions of a major oil province.

It would be extremely difficult to draw a more striking comparison than the oil-field discovery possibilities facing American and Russian geologists and drillers. In the United States, in the oil-producing states practically every square mile has been minutely examined for surface structures, has been either core drilled or surveyed with geophysical instruments, and finally has been tested by drill. Moreover, the large proportion of the probable oil-producing territory has been studied in detail by many geologists and geophysicists of many oil companies, as well as by Federal and by State geological surveys. It is estimated that in 1936 more than 50 per

[1] Read before the Association at Los Angeles, March 18, 1937. Manuscript received, April 23, 1937.

[2] Geologist, department of petroleum economics, The Chase National Bank.

cent of newly blocked-out reserves was discovered by means of geophysics, while an ever larger proportion of failures was being completed on various geophysical prospects as the more obvious situations have been explored. Thus in the United States future discoveries will depend on most minute and painstaking studies and correlation of all accumulated evidence of the past, including surface, subsurface, geological and geophysical data, with particular attention to the search for sand reservoirs of unconformable type, with special attention to new geophysical methods, and with due regard to rank wildcatting. In Russia an exactly opposite picture exists. The exploration possibilities offered today to Russian geologists by virtue of the latest American technique are unlimited. Imagine the country explored by comparison with the United States as the United States was developed in 1900 with an enormous number of obvious surface structures of major size, and probably with an equally large number of less clearly indicated surface folds, still untested, these conditions to be tackled by most modern exploration practices, including surface work, core drilling, seismographs, magnetometers, *et cetera*, and with the fully developed technique of subsurface records, including lithologic and paleontological work, as well as electrical well logging. While a large amount of geophysical work is being done today in Russia, more particularly in the apparently secondary district of the Emba salt domes, good surface geological work, with gradually developing subsurface control and study of major structural trends, can supply the country with all the fields it will need for the next 25 years or more. On and near Apsheron Peninsula (Baku district) structural features are plainly revealed on the surface. Similarly favorable conditions exist in the Grozny area of North Caucasus; also all along the foothills of the Caucasian Mountain range from the Apsheron Peninsula on the southeast to the Taman Peninsula on the northwest and on the Crimean Peninsula. Surface indications are also distinct in the Ural-Permian area and in Turkestan. Undoubtedly a large number of structures has been already mapped by geologists and is awaiting exploration by drill.

The drill, however, is still antiquated and in some places unavailable for active exploration. Some measure of progress has been made in rapid and effective drilling in the large proved fields of Baku and Grozny, where all facilities are available, but wildcatting away from bases of supply continues to be almost impossible. The obvious solution of the impassé, and the one made, appeared to be the choice of better structural prospects and their equipment along the lines of a large producing oil field with power lines for drilling, water lines,

machine shops, living quarters, roads, *et cetera*. Under these conditions the chosen structures are developed in a major manner and 10–15 wells are started simultaneously on the different contour lines of the indicated structure. But even with these developments long

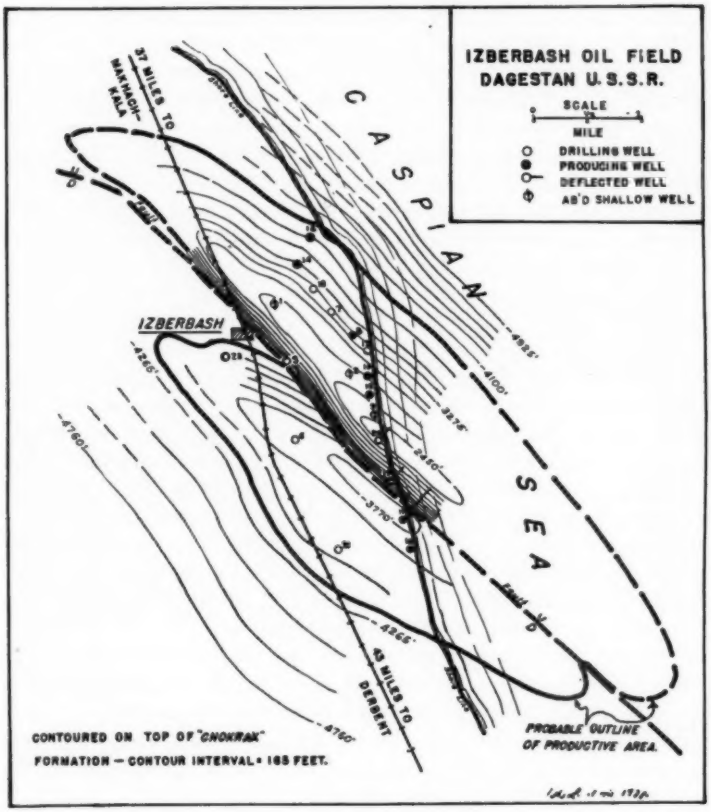

FIG. 1

delays occur due to distances and difficulties of requisitions from main supply stations in Baku or in Grozny. With the country practically unexplored, such a method is not entirely unsound and appears to fit the circumstances, as the recent discoveries of Izberbash and Gorski indicate. In Izberbash (Fig. 1) 14 wells were begun before any production was proved and 7 of these have been completed as gushers, after an extended period of drilling, but because of the usual

irresponsibility attendant on the development of new fields, the light oil is still kept in open earth storage and the field is as yet unconnected by pipe lines, even though it is on the railroad and only a few miles from a trunk pipe-line terminal at Makhach-Kala; if similar conditions had existed in the United States, the new field would have had a preliminary pipe-line outlet within one week of completion of the first well and a trunk line within a month.

During 1936, the Russian oil industry, pursuing the indicated policy, was successful in discovering several important fields, though most of these remained unconnected by pipe lines and their development was delayed by lack of necessary supplies, skilled technicians, and labor. Izberbash and Achi-Su, on the western shore of the Caspian Sea in Dagestan, were the outstanding discoveries, extremely well located strategically for the disposition of the crude oil. The production in Izberbash is derived from the Chokrak series of the Miocene, initial production ranging to as much as 4,000 barrels per day from depths of 5,000 or 6,000 feet. The structure is a large anticlinal feature divided by a major fault with a throw of about 1,000 feet. Half of the structure is located under the Caspian Sea and 3 wells which have been drilled have been deflected from the shore. Achi-Su, located near Izberbash, is a shallow field with producing sands encountered at 2,400 feet and with production ranging from 70 to 200 barrels per day; Achi-Su is expected to cover a very considerable area according to surface indications and therefore represents a large reserve. On the Apsheron Peninsula in the older fields deeper penetration into the Oil Measures of the Pliocene disclosed additional reserves of first magnitude. In Surakany field the deepest producer yet completed in Russia produced about 4,000 barrels per day at 8,150 feet from pre-Kirmaku sands. A considerable number of deeper possibilities still remain in Surakany, Kara-Chukur and Zikh fields, all of these forming the southernmost plunging extension of the main structural axis of the Apsheron Peninsula. In the Puta district several important developments occurred during the past year, including discoveries and extensions at Shangar, at Kergez, and at Kizil-Tepe. In the Saliani Steppes, south of the Apsheron Peninsula, a major field was discovered at Pirsagat, production being derived at 4,500 feet from the Oil Measures of the Pliocene with production ranging to as much as 2,500 barrels per day. Pirsagat, however, still remained entirely undeveloped early in 1937.

In North Caucasus, in the Grozny district, on a very well pronounced structural and topographic feature of the Terek range, which is a major foothill range paralleling the Caucasus Mountains, an important discovery was made early in 1937 at Gorsky, when

well No. 8 came in, with a production of 3,500 barrels initially from 4,000 feet. In Gorsky 7 wells were begun in 1936 and, on completion of the discovery, 6 additional wells were projected. In Maikop and Kuban districts in North Caucasus several shallow fields were discovered, the most important ones being Asphalt Mountain, Kutaisky, in Maikop, and Adagum and Keslerovo, in Kuban. Of particular value is the Asphalt Mountain, where two horizons were proved to be productive, one at 1,620 feet and the other at 2,800 feet, the initial production ranging up to 7,000 barrels and the wells holding up remarkably well. In the older Grozny fields the Old and New fields continued their precipitate decline and the more recent discovery of Malgobek accounted for 40 per cent of the production in the district during 1936.

In Ural Permian basin, Ishimbaevo field in Bashkir Steppes, the first major field of the basin, produced, in 1936, 6,780,000 barrels, at the rate of 18,500 barrels per day, and its production was to be doubled in 1937. In the structurally classical Samarsky-Luki range of hills, which abruptly deflects the Volga River about 40 miles from its normal course, very promising results were obtained in preliminary exploration work.

In the Emba district nothing of importance occurred and this salt-dome district continued to be disappointing and it is doubtful whether its reserves can at all compare with the Gulf Coastal salt domes of the United States.

In conclusion, it can be said that the Russian government itself does not have any illusions as to its accomplishments. The Commissar of Heavy Industries stated during 1936 that the Russian oil industry is still in a "barbaric" state. At the same time, however, a gradual, if slow, progress is definitely being made. The domestic demand is undoubtedly being supplied in a fairly satisfactory degree, though many of the less vital consumers are left without products and the exports are being decreased. The service of supply, means of communication, and red tape still constitute an immense and unsurmountable obstacle to operations elsewhere than at the principal bases. It is estimated that the proved (blocked-out) reserves ready for exploitation in the U.S.S.R. are, at this time, inclusive of 1936 discoveries, approximately 4,500 million barrels, of which 500 million barrels was added in new fields and extensions of old fields during the past year. Russian estimates, based on probable discovered and undiscovered oil in the current producing districts, range to as much as 35 billion barrels and obviously do not represent a true reserve picture as understood in the United States.

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WILDCAT DRILLING IN 1935 AND 1936[1]

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ABSTRACT

A study of wildcat drilling in the Gulf Coast Plain during 1935 and 1936 indicates that between 7 and 11 per cent of all such holes opened new oil or gas pools, the remaining 93–89 per cent having been dry. These figures speak eloquently of the risk involved in wildcat drilling. The suggestion is made that a comprehensive study of this factor be undertaken for other parts of the United States, and annually.

The technique of oil exploration is constantly developing. New methods of search are being discovered and applied, and old methods are being improved. Likewise, methods of drilling are becoming in-

FIG. 1.—Wildcats, 1935. (See Figure 2 for explanation.)

FIG. 2.—Wildcats, 1936.

On both maps, figures in parentheses indicate footage drilled; figures preceding parentheses indicate number of holes drilled; figures above the cross line indicate producing or discovery wells; figures below this line indicate dry holes.

[1] Manuscript received, April 8, 1937.

[2] Chief geologist, Sun Oil Company.

creasingly efficient. Yet, with all the advances made in the various means of seeking and exploiting oil, there still remains a large risk in the business of discovery. This becomes apparent in a study of wildcat drilling.

1935

District	Oil and Gas Wells	Footage	Dry Holes	Footage
1. Alabama	—	—	5	21,683
2. Arkansas (So.)	—	—	46	138,456
3. Florida	—	—	1	4,565
Louisiana				
4. North	3	17,074	49	139,280
5. South	6	40,871	41	255,091
6. Mississippi	—	—	15	56,376
7. New Mexico (S.E.)	4	15,027	32	99,271
Texas				
8. East	2	11,971	191	592,615
9. Huntsville	3	19,595	74	302,215
10. Houston	3	22,292	34	217,180
11. Beaumont	3	21,564	24	159,826
12. San Antonio	5	15,996	139	259,274
13. S.W. Texas	36	138,776	253	876,955
14. West Texas	13	51,668	83	292,509
Totals				
A. 1+2+3+6	—	—	67	419,795
B. 4+8+9+12	13	64,636	453	1,293,384
C. 5+10+11	12	84,727	99	632,097
D. 7+14	17	66,695	115	391,780
E. 13	36	138,776	253	876,955
F. Grand total	78	354,834	987	3,614,011

On basis of total holes drilled 100 per cent and total footage drilled 100 per cent

	Per Cent Producing	Per Cent Dry	Per Cent Producing Footage	Per Cent Dry Footage
A	0	100	0	100
B	2.789	97.211	4.752	95.248
C	11.111	88.889	11.819	88.181
D	12.878	87.122	14.547	85.453
E	12.456	87.544	13.662	86.338
F	7.324	92.676	8.940	91.060

On basis of grand totals, for every foot drilled in producing wells, there were drilled in 1935, 10.31 feet of dry hole.

We have made a little investigation of the results of wildcat drilling, for the years 1935 and 1936, in the area comprising Florida, Alabama, Mississippi, southern Arkansas, Louisiana, southeastern New Mexico, and all of Texas except the Panhandle and the north-

central part of the state. Only true wildcats are included, that is, holes drilled completely separate from producing pools. Not even extension wells of existing pools have been included. Probably a majority of these wildcats have been located on some geological or geo-

1936

District	*Oil and Gas Wells*	*Footage*	*Dry Holes*	*Footage*
1. Alabama	—	—	3	11,518
2. Arkansas (So.)	3	11,331	53	191,567
3. Florida	—	—	2	3,121
Louisiana				
4. North	10	60,659	75	232,898
5. South	5	34,784	44	283,831
6. Mississippi	—	—	11	40,538
7. New Mexico (S.E.)	7	25,366	19	69,782
Texas				
8. East	6	27,367	123	411,497
9. Huntsville	5	32,443	61	282,477
10. Houston	5	34,412	20	126,715
11. Beaumont	6	42,236	38	251,190
12. San Antonio	2	7,514	110	215,021
13. S.W. Texas	49	183,817	318	1,168,365
14. West Texas	18	67,357	94	297,156
Totals				
A. 1+2+3+6	3	11,331	69	246,744
B. 4+8+9+12	23	127,983	369	1,141,893
C. 5+10+11	16	111,432	102	661,736
D. 7+14	25	92,723	113	366,938
E. 13	49	183,817	318	1,168,365
F. Grand total	116	527,286	971	3,585,676

On basis of total holes drilled 100 per cent and total footage drilled 100 per cent

	Per Cent Producing	*Per Cent Dry*	*Per Cent Producing Footage*	*Per Cent Dry Footage*
A	4.166	95.834	4.351	95.649
B	5.867	94.133	10.070	89.930
C	13.559	86.441	14.412	85.588
D	18.116	81.884	20.172	79.828
E	13.350	86.650	13.594	86.406
F	10.671	89.329	12.820	87.180

On basis of grand totals, for every foot drilled in producing wells, there were drilled in 1936, 6.83 feet of dry hole.

physical suggestion of structure, such as regional trend, flattening of the dip, closure associated with doming of one kind or another, faulting, and so on. Sometimes weak suggestions of surface or subsurface structure are found, on drilling, to be incorrect, but, more

commonly, expected pay sands are found to be absent, or too shaly or of too low permeability to yield oil. Subsurface conditions are difficult to predict from present technical methods of exploration, and in many places two or more holes are needed to prove or disprove the commercial possibilities even of a clearly recognized structure. Therefore, as has always been true, and as probably always will be true, wildcatting involves a large element of risk.

A study of the tables and the maps (Figs. 1 and 2) indicates that in 1935, in the area under discussion, 78 holes discovered new oil pools or gas pools, whereas 987 holes were failures and were abandoned as dry. In the 78 discovery wells, 354,834 feet of hole were drilled; in the 987 failures, 3,614,011 feet. In 1936, in the same region, there were 116 discovery wells, totaling 527,286 feet of hole drilled, and 971 dry holes with a total of 3,585,676 feet. In 1935, 7.32 per cent of all the holes drilled were successful and 92.68 per cent were dry; and in 1936, 10.67 per cent were successful, and 89.33 per cent were dry. In 1935, one foot of producing hole was drilled for every 10.31 feet of dry hole, and in 1936 one foot of producing hole for every 6.83 feet of dry hole.

We do not think that the greater success in 1936 is a measure of improved technique. It is more probably due to chance. In order to check this more closely, a similar study should be made of wildcat drilling in previous years for some period. We strongly recommend that this kind of analysis be made annually, and for all oil-producing territory in the United States. The results may be used in estimating at least one phase of the financial risks incurred in wildcatting.

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GEOLOGIC SECTIONS IN TEXAS AND ADJOINING STATES[1]

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Houston, Texas

ABSTRACT

The geologic sections presented herewith are the result of accumulated data from various districts in Texas, assembled by the writer for several years. These were finally drafted in their present form, not with the idea of publication, but as a handy reference to geological conditions in various areas. These sections have been found useful in obtaining a generalized picture of regional geology throughout large areas and the interrelationship of various geologic provinces to each other. They also show, in a general way, the thickness of geologic formations and approximate depths to producing horizons as well as the principal types of accumulation, both structural and stratigraphic, found in Texas.

The accompanying cross sections are the result of work by the writer, in several different districts of Texas, during the past 10 or 12 years. In each of these districts, cross sections were prepared from time to time, as they are prepared in every oil company geological department, some showing local details, and some showing regional features in their relation to the particular district. Later these were combined wherever possible, not with the idea of publication, but to show the relationship of one district to another and also the approximate thickness of, and depth to, geologic formations in various parts of the state. Almost every type of accumulation, whether structural or stratigraphic, found in Texas, has been included, such as anticlines, salt domes, lensing sands, unconformities, and also most of the various horizons in the geologic column which produce oil and gas. The scale adopted was one that would make principal features stand out, but with a minimum of distortion.

These sections are obviously not intended as detailed studies, but are intended to show broad relationship of structure and stratig-

[1] Manuscript received, May 31, 1937.

[2] General Crude Oil Company.

Much of the information used in these sections was taken from the publications of the United States Geological Survey and the American Association of Petroleum Geologists. Credit for such prior publication is given on each section. Also, on each section is shown the names of persons who contributed materially in time and information that went into its construction. Aside from these, the writer wishes to acknowledge the suggestions and encouragement given by A. I. Levorsen, who is largely responsible for having these sections published, and the help in compiling and drafting by A. N. Wilson, of The General Crude Oil Company.

Included in this set of sections is one of South Texas by Willis Storm and Charles H. Row.

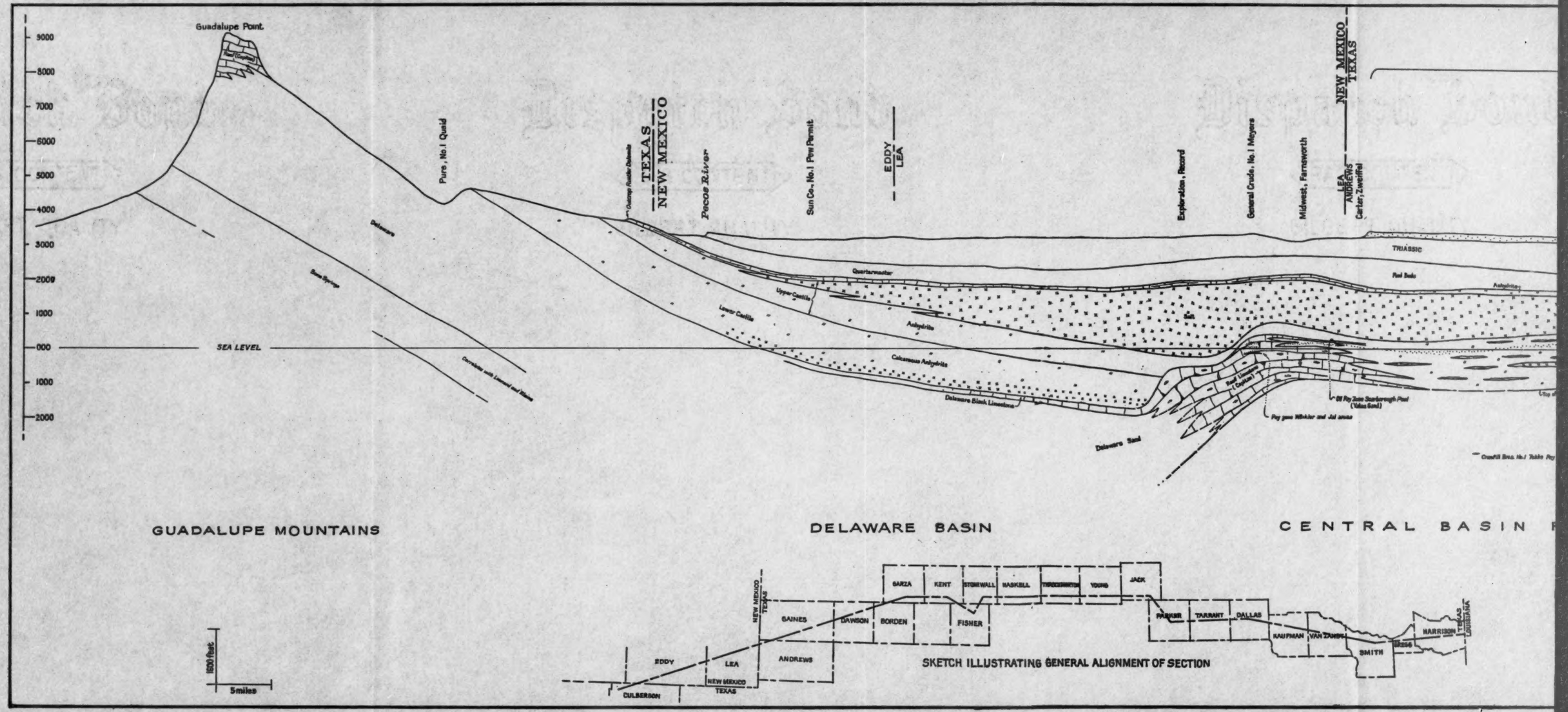
raphy from one area to another, and details are used only to bring out these features. Furthermore, the structural and stratigraphic interpretations shown may not be accepted as absolutely accurate by all members of the profession who may be acquainted with details of a given area much better than the writer.

Obviously, well logs are of major importance in a work of this sort, but these sections do not necessarily portray conditions existing along a certain line of drilled wells. Since detailed structure and stratigraphy were not the objects of this compilation, some wells that showed too much abnormality, or correlation of which was questionable, were not used.

In view of the vast amount of information of this sort in company files and in the geologic literature, the writer ventures to suggest that other cross sections of Texas and other large areas be constructed. Perhaps the scale and type of portrayal used in this set would not be applicable to other areas, but a series of sections of various states or areas, some of which could be joined together, would make an interesting and valuable contribution to geology. These need not be confined to oil-producing areas, although admittedly such areas furnish the greatest source of information.

While each section is self-explanatory, several of the salient features shown are pointed out in the following brief description of each section.

Section *A* is a west-east section, extending from Guadalupe Peak, Culberson County, to Harrison County. Near its western end, the section crosses a part of New Mexico, but the features shown here are not essentially different from those in Texas fields, a few miles south. The main features shown from west to east are: the West Texas Permian basin, including the Central Basin platform and the Delaware basin, the Bend arch, and the East Texas syncline, or Tyler basin. Types of structural traps include an unconformity, as in the East Texas field, a faulted dome at Van, porous limestone and sand production on various types of structure in West Texas and in the Bend arch areas. No attempt has been made to differentiate the Cisco and Strawn sand zones in North Texas. In the Permian basin area, the beds show profound thickening basinward from their outcrop and an attempt has been made to show the outstanding features of gradation from red beds to salt, anhydrite to limestone, *et cetera*. In the Bend arch area, the most noticeable structural feature is the rapid eastward thickening of the Strawn formation. The East Texas basin section shows the unconformable relationship which causes the accumulation in the East Texas field, together with an interior salt


Guadalupe Point
9000
8000
7000
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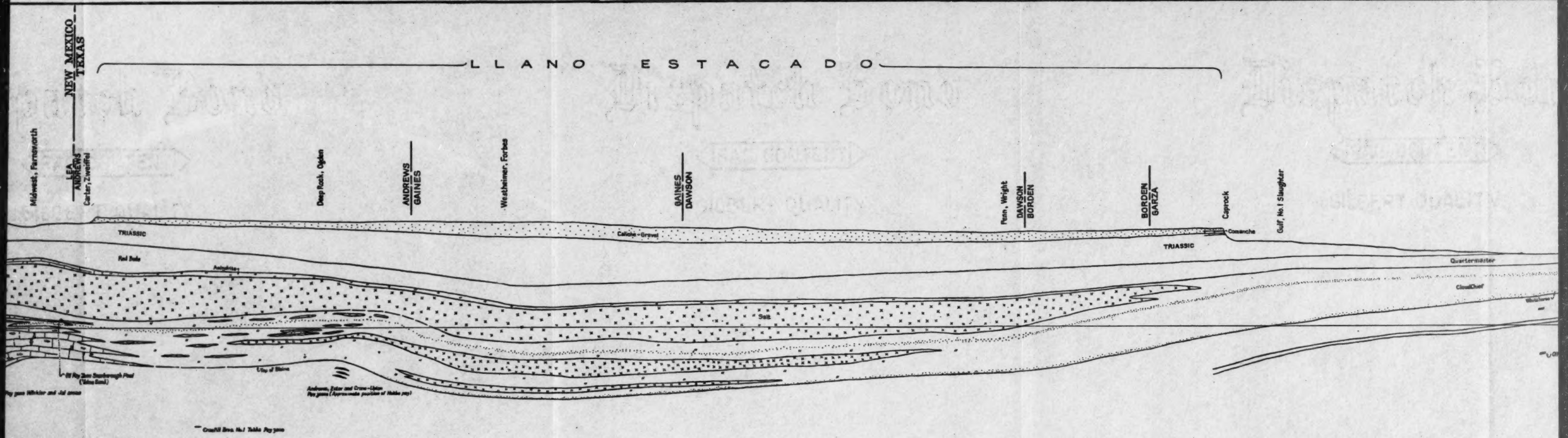
SEA LEVEL
Delaware
Base Springs
Carnallite with Leonard and Wolfcamp
Pure, No. 1 Quaid
TEXAS
NEW MEXICO
Pecos River
Sun Co., No. 1 Pew Permit
EDDY
LEA
Exploration, Record
General Crude, No. 1 Meyers
Midwest, Farnsworth
NEW MEXICO
TEXAS
LEA
ANDREWS
Carter, Zweifel
TRIASSIC
Quartermaster
Upper Castile
Lower Castile
Anhydrite
Salt
Red Beds
Anhydrite
Red Lime
Capitan
Delaware Sand
GUADALUPE MOUNTAINS
DELAWARE BASIN
CENTRAL BASIN
1200 feet
5 miles
NEW MEXICO
TEXAS
EDDY
LEA
CULBERSON
NEW MEXICO
TEXAS
GAINES
DAWSON
BORDEN
ANDREWS
GARZA
KENT
STONEWALL
HASKELL
THROCKMORTON
YOUNG
JACK
FISHER
PARKER
TARRANT
DALLAS
KAUFMAN
VAN ZANDT
SMITH
RUSK
HARRISON
TEXAS
LOUISIANA
SKETCH ILLUSTRATING GENERAL ALIGNMENT OF SECTION

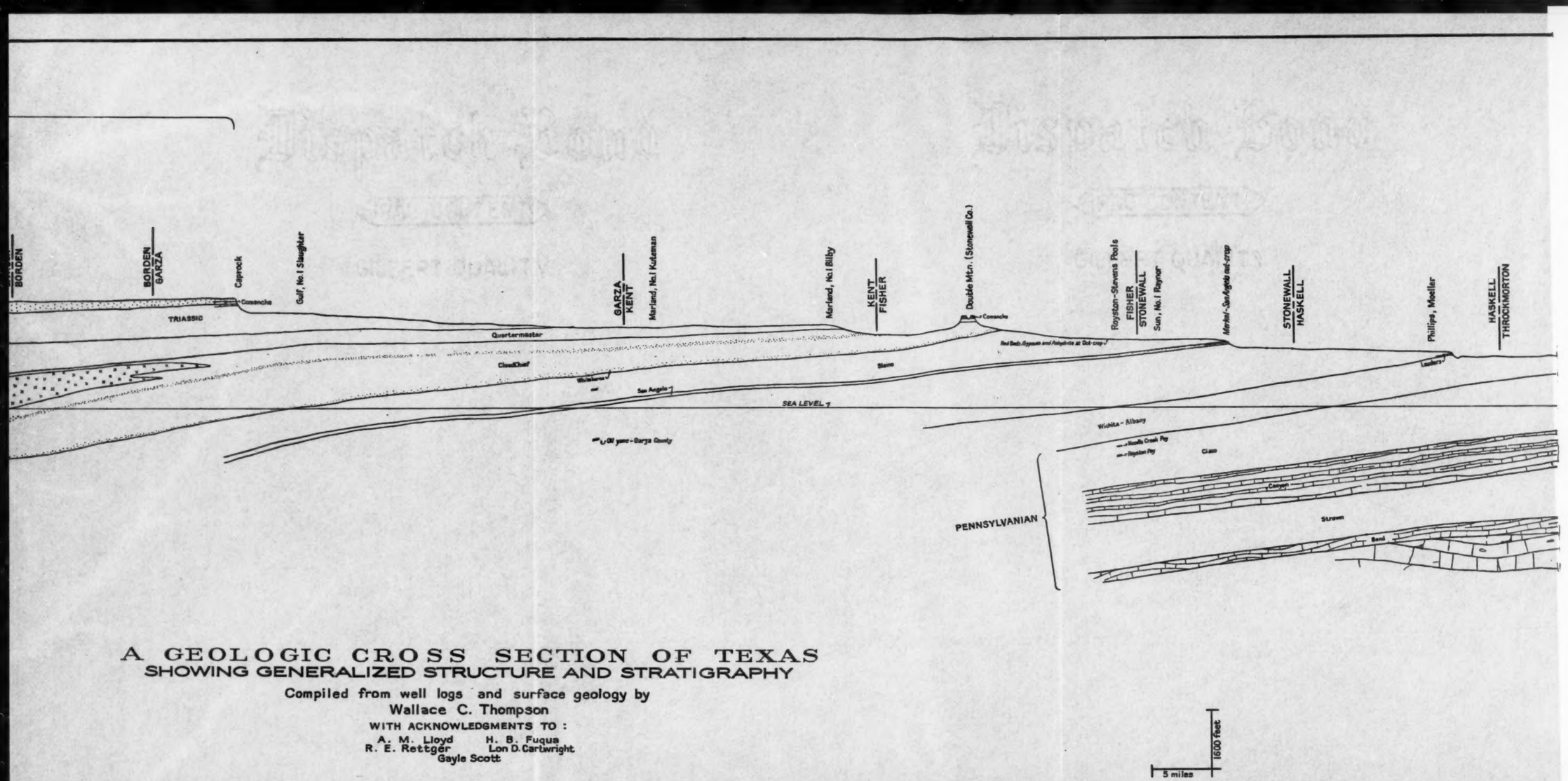


CENTRAL BASIN PLATFORM

A GEOLOGIC CROSS SECTION
SHOWING GENERALIZED STRUCTURE AND

Compiled from well logs and surface geology
Wallace C. Thompson

WITH ACKNOWLEDGMENTS TO :
A. M. Lloyd H. B. Fuqua
R. E. Rettger Lon D. Cartwright
Gayle Scott



A GEOLOGIC CROSS SECTION OF TEXAS
SHOWING GENERALIZED STRUCTURE AND STRATIGRAPHY

Compiled from well logs and surface geology by
Wallace C. Thompson

WITH ACKNOWLEDGMENTS TO :
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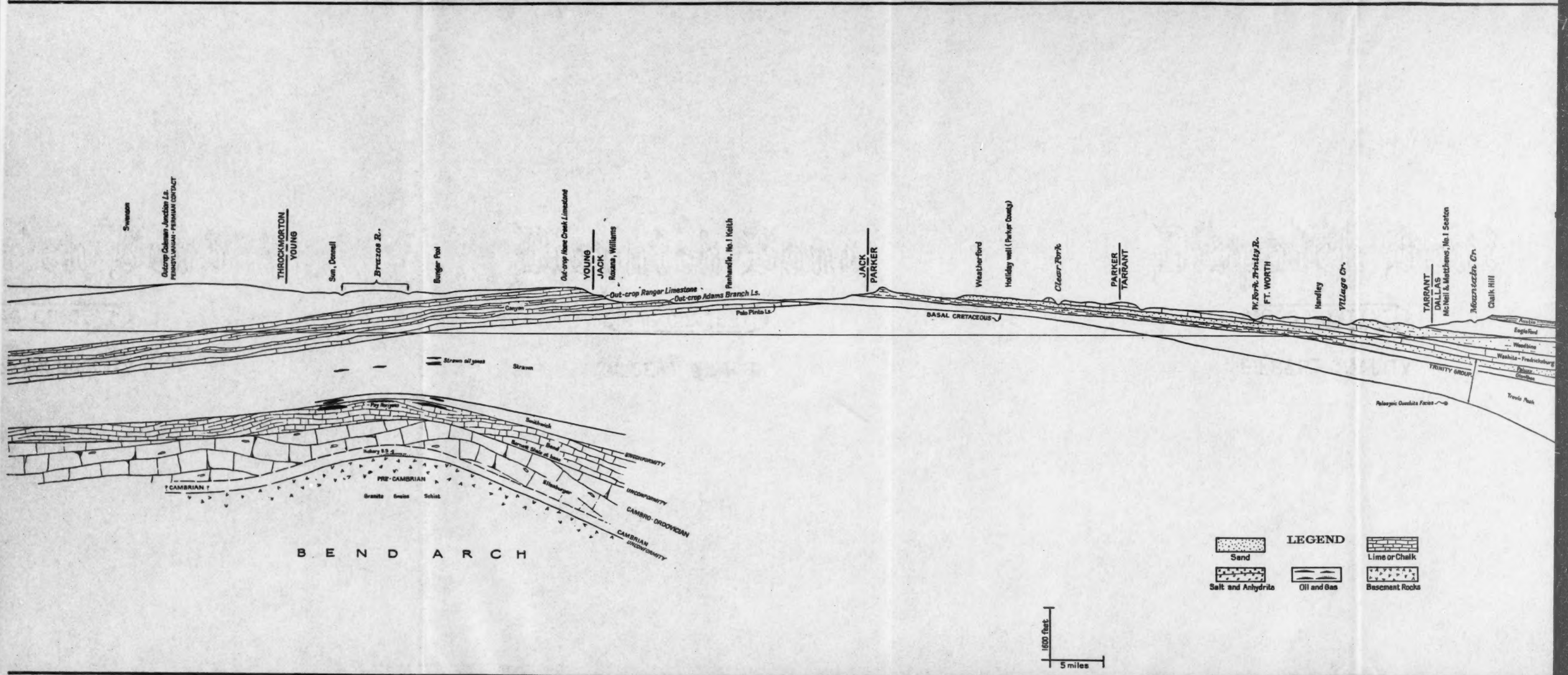
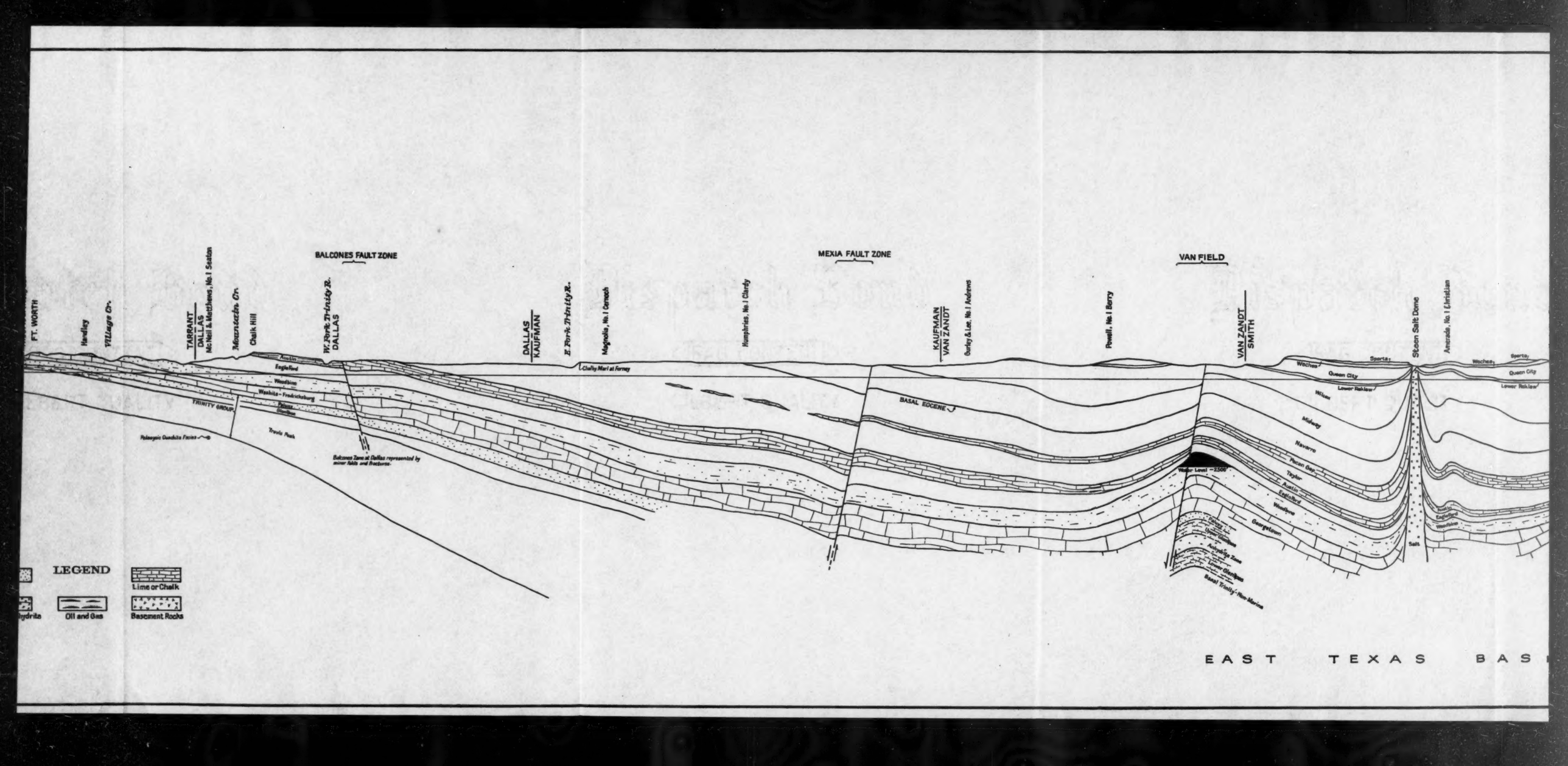
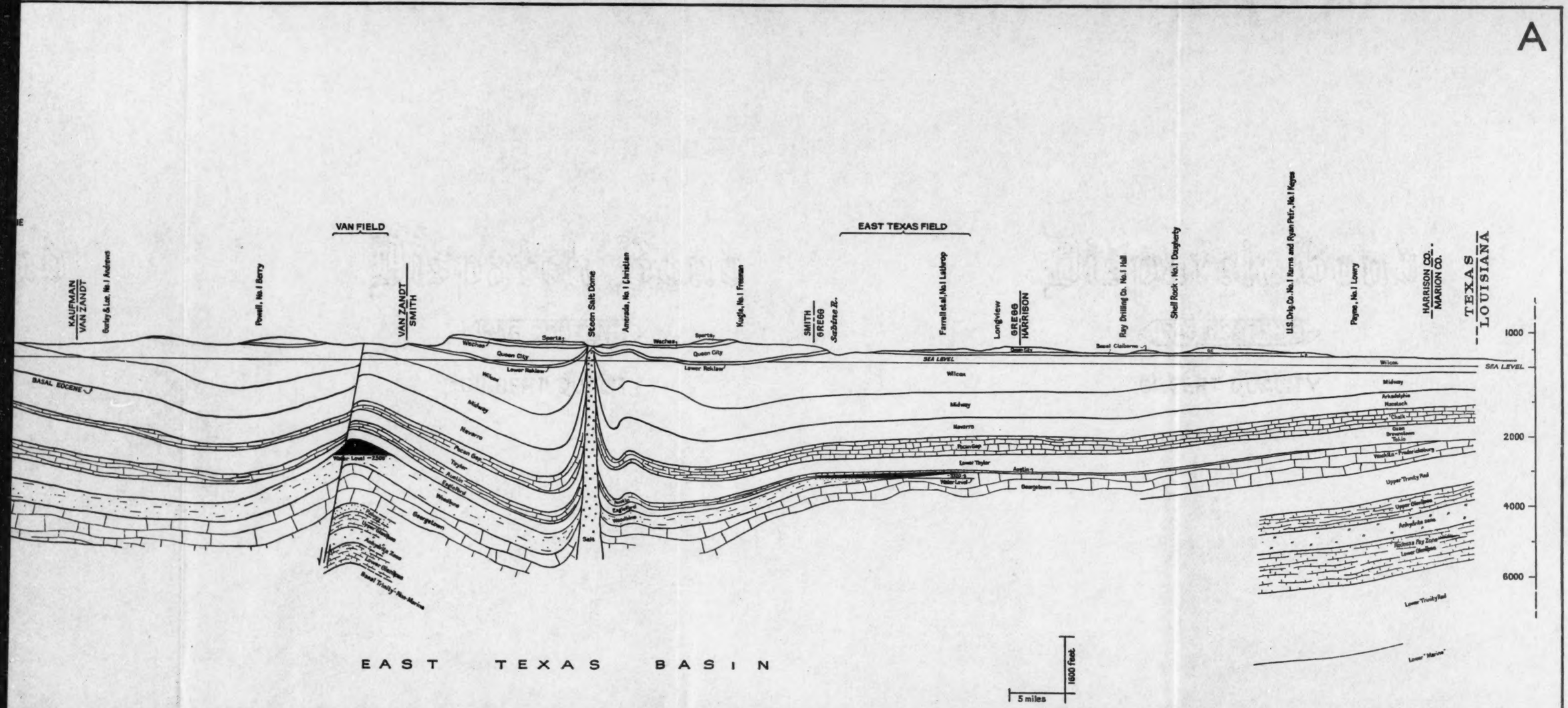
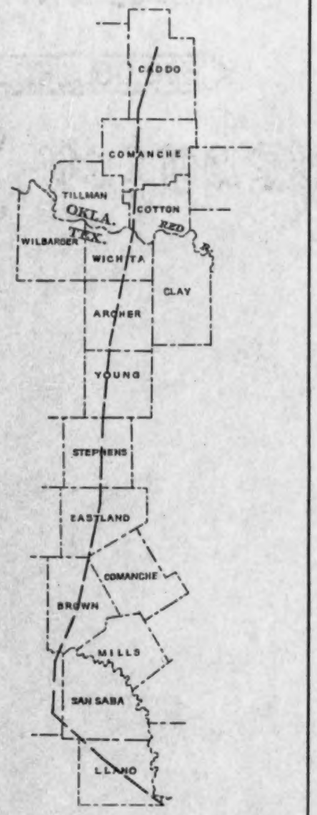
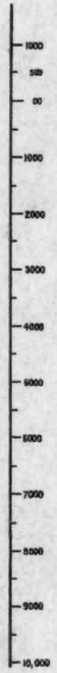

Swenson
Outcrop Coleman Junction Ls.
PENNSYLVANIAN - PERMIAN CONTACT
THROCKMORTON
YOUNG
Sun, Donnell
Brazos R.
Burger Pool
Out-crop Home Creek Limestone
YOUNG
JACK
Rosana, Williams
Out-crop Ranger Limestone
Out-crop Adams Branch Ls.
Panhandle, No.1 Keith
Palo Pinto Ls.
JACK
PARKER
Westherford
Halliday well (Parker County)
Clear Fork
PARKER
TARRANT
W. Fork Trinity R.
FT. WORTH
Handley
Village Cr.
TARRANT
DALLAS
McNeil & Matthews, No.1 Sexton
Mountain Cr.
Chalk Hill
Austin
Eagle Ford
Woodbine
Washita - Fredricksburg
Paluxy
Glen Rose
Travis Peak
BASAL CRETACEOUS
TRINITY GROUP
Paleozoic Quachita Facies
Strawn oil zones
Strawn
Pay Horizon
Bankwitch
Barnett Shale at base
Ellenburger
UNCONFORMITY
CAMBRO-ORDOVICIAN
CAMBRIAN
UNCONFORMITY
PRE-CAMBRIAN
? CAMBRIAN ?
Granite
Gneiss
Schist
BEND ARCH
LEGEND
Sand
Lime or Chalk
Salt and Anhydrite
Oil and Gas
Basement Rocks
1600 feet
5 miles

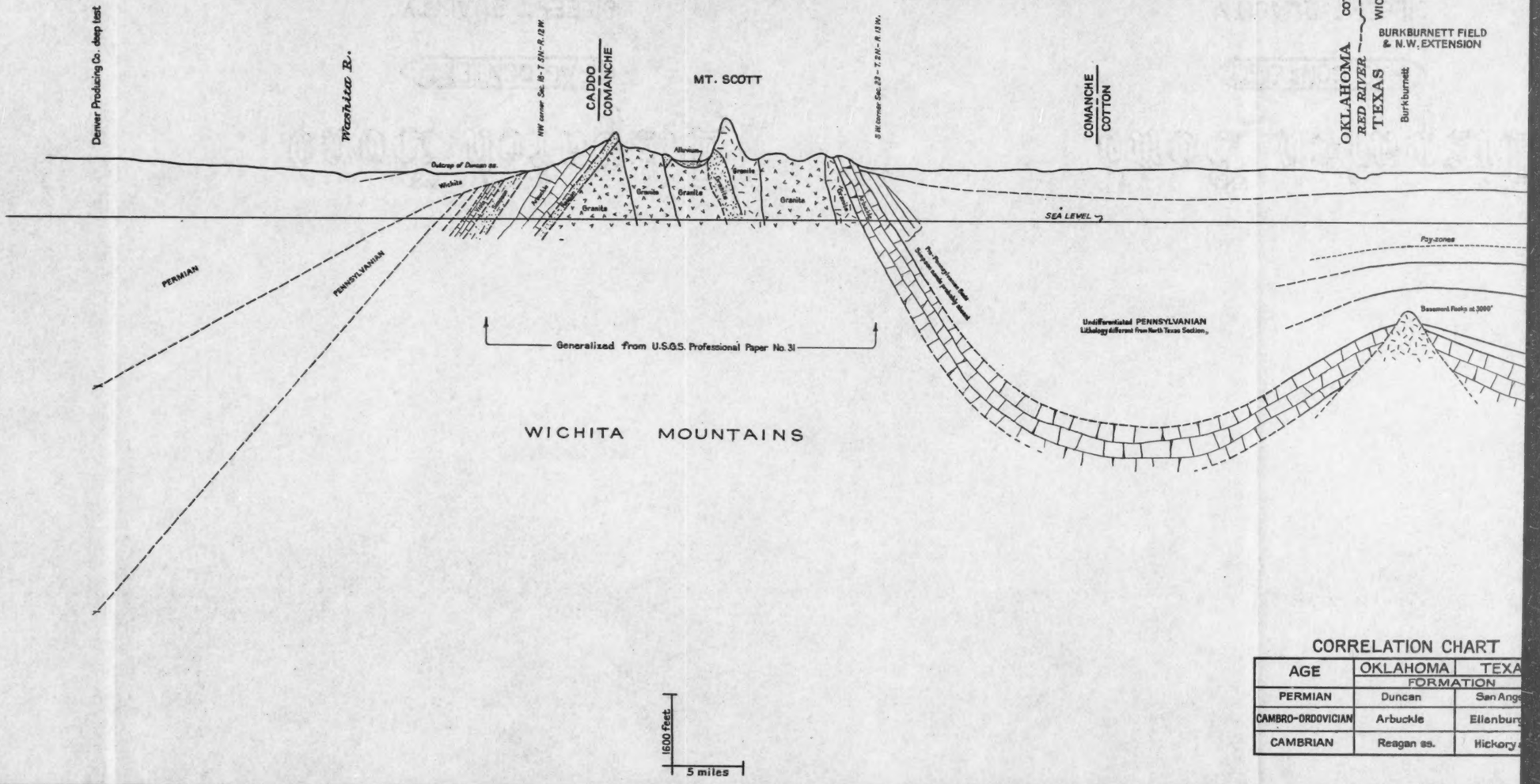

BALCONES FAULT ZONE
MEXIA FAULT ZONE
VAN FIELD
FT. WORTH
Hendley
Village Cr.
TARRANT
DALLAS
Mc Neil & Matthews, No. 1 Seaton
Mountain Cr.
Chalk Hill
W. Fork Trinity R.
DALLAS
DALLAS
KAUFMAN
E. Fork Trinity R.
Magnolia, No. 1 Genoch
Humphries, No. 1 Clardy
KAUFMAN
VAN ZANDT
Gurley & Lee, No. 1 Andrews
Powell, No. 1 Berry
VAN ZANDT
SMITH
Steen Salt Dome
Amerada, No. 1 Christian
Austin
Eagleford
Woodbine
Washita - Fredricksburg
Paluxy
Glen Rose
TRINITY GROUP
Paleozoic Quachita Facies
Travis Peak
Chalky Marl at Forney
BASAL EOCENE
Water Level -2500'
Wilcox
Midway
Navarro
Pecan Gap
Taylor
Austin
Eagleford
Woodbine
Georgetown
Salt
Basal Trinity - Pre-Mesozoic
Balcones Zone at Dallas represented by minor folds and fractures.
LEGEND
Lime or Chalk
Oil and Gas
Basement Rocks
EAST TEXAS BAS


A
VAN FIELD
EAST TEXAS FIELD
KAUFMAN
VAN ZANDT
Gurley & Lee, No. 1 Andrews
Powell, No. 1 Berry
VAN ZANDT
SMITH
Steen Salt Dome
Amerada, No. 1 Lindsley
Kugle, No. 1 Freeman
SMITH
6RE66
Sabine R.
Farrell Estate, No. 1 Lathrop
Longview
6RE66
HARRISON
Ray Drilling Co. No. 1 Hall
Shell Rock . No. 1 Dougherty
U.S. Drlg. Co. No. 1 Rains and Ryan Petr., No. 1 Keyes
Payne, No. 1 Lowry
NARRISON CO.
MARION CO.
TEXAS
LOUISIANA
BASAL EOCENE
Wilcox
Queen City
Lower Reklaw
Midway
Navarro
Taylor
Austin
Eagleford
Woodbine
Georgetown
Sabine
Water Level -2500'
SEA LEVEL
Basal Claiborne
Midway
Arkadelphia
Nanafoch
Chalk
Upper Trinity Red
Upper Glenrose
Anhydrite zone
Lower Glenrose
Lower Trinity Red
Lower "Marine"
1000
2000
4000
6000
EAST TEXAS BASIN
1600 feet
5 miles



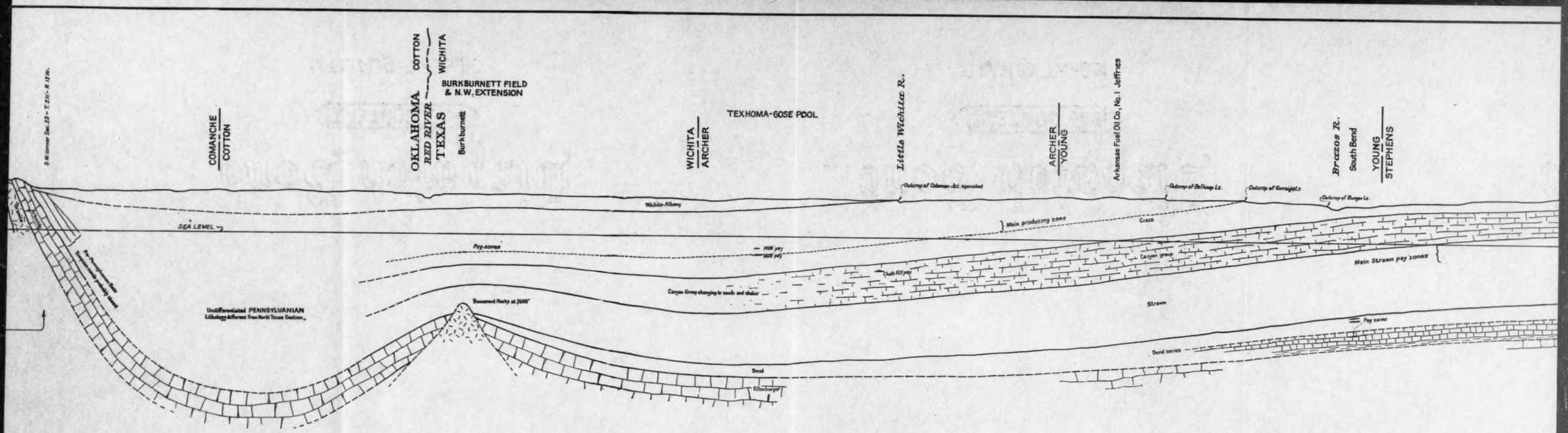
SKETCH ILLUSTRATING GENERAL ALIGNMENT OF SECTION
NORTH PORTION





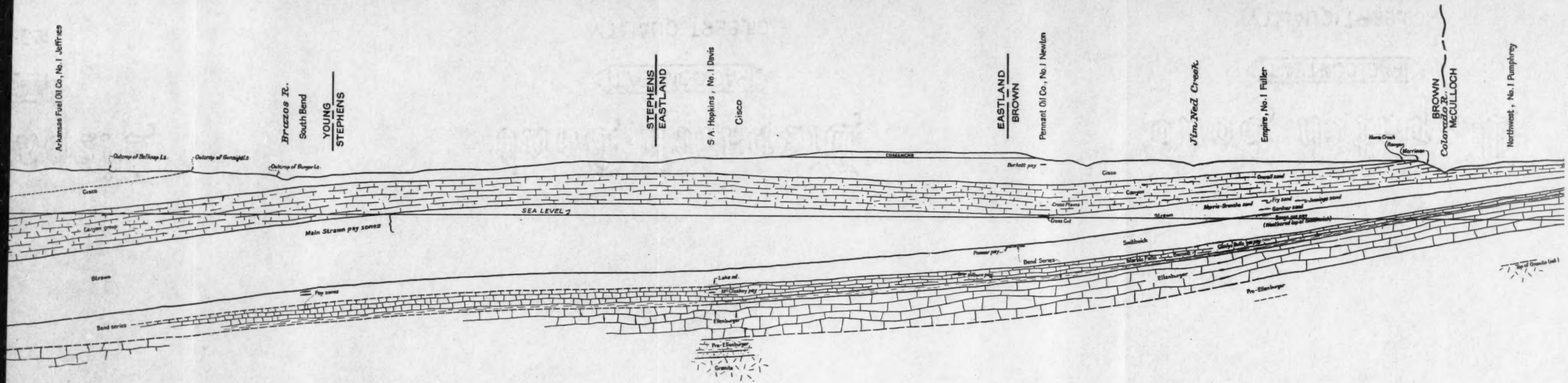
CORRELATION CHART

AGE	OKLAHOMA	TEXA
	FORMATION	
PERMIAN	Duncan	San Ang
CAMBRO-ORDOVICIAN	Arbuckle	Ellenburg
CAMBRIAN	Reagan ss.	Hickory



CORRELATION CHART

AGE	OKLAHOMA	TEXAS
	FORMATION	
PERMIAN	Duncan	San Angelo
CAMBRO-ORDOVICIAN	Arbuckle	Ellenburger
CAMBRIAN	Reagan ss.	Hickory ss.

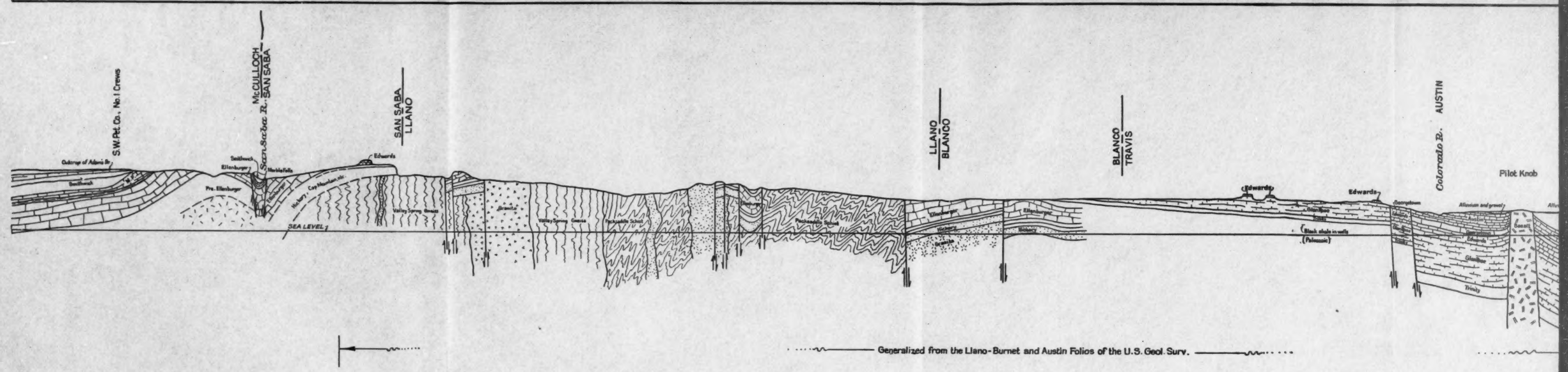


KEY MAP

1600 Feet

5 miles

A. N. Wilson 6-36



CENTRAL MINERAL REGION

BALCONES FAULT ZONE

A GEOLOGIC CROSS-SECTION FROM CADDO COUNTY, OKLAHOMA THROUGH THE CENTRAL MINERAL REGION OF TEXAS TO THE GULF OF MEXICO

SHOWING GENERALIZED STRUCTURE AND STRATIGRAPHY

Compiled from Well Logs, Surface Geology and Published Data
by Wallace C. Thompson

WITH ACKNOWLEDGMENTS TO

M. G. Cheney
Dow Hamm
Jos. M. Dawson
Frank E. Kendrick
John R. Sandidge
Thos. J. Galbraith
Stuart Mossom

LEGEND

Sand

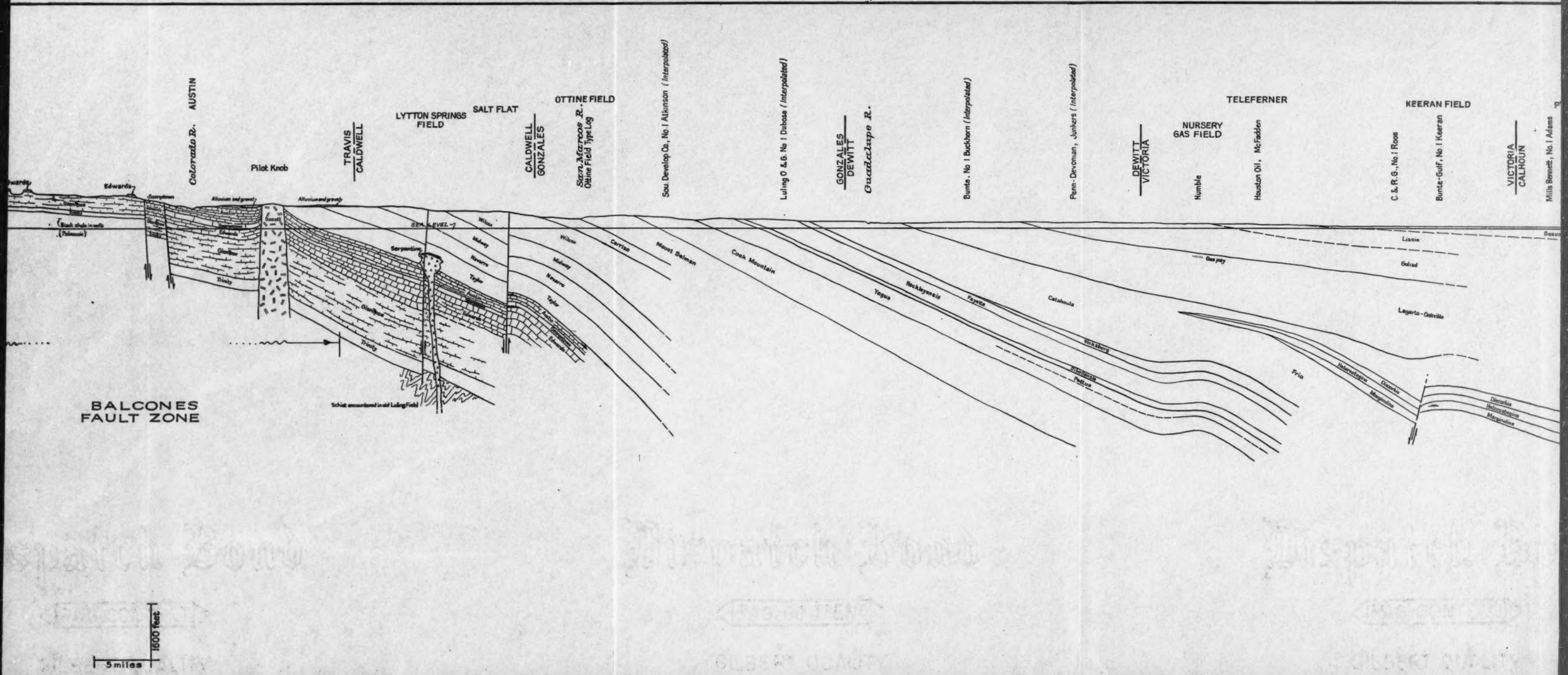
Lime or Chalk

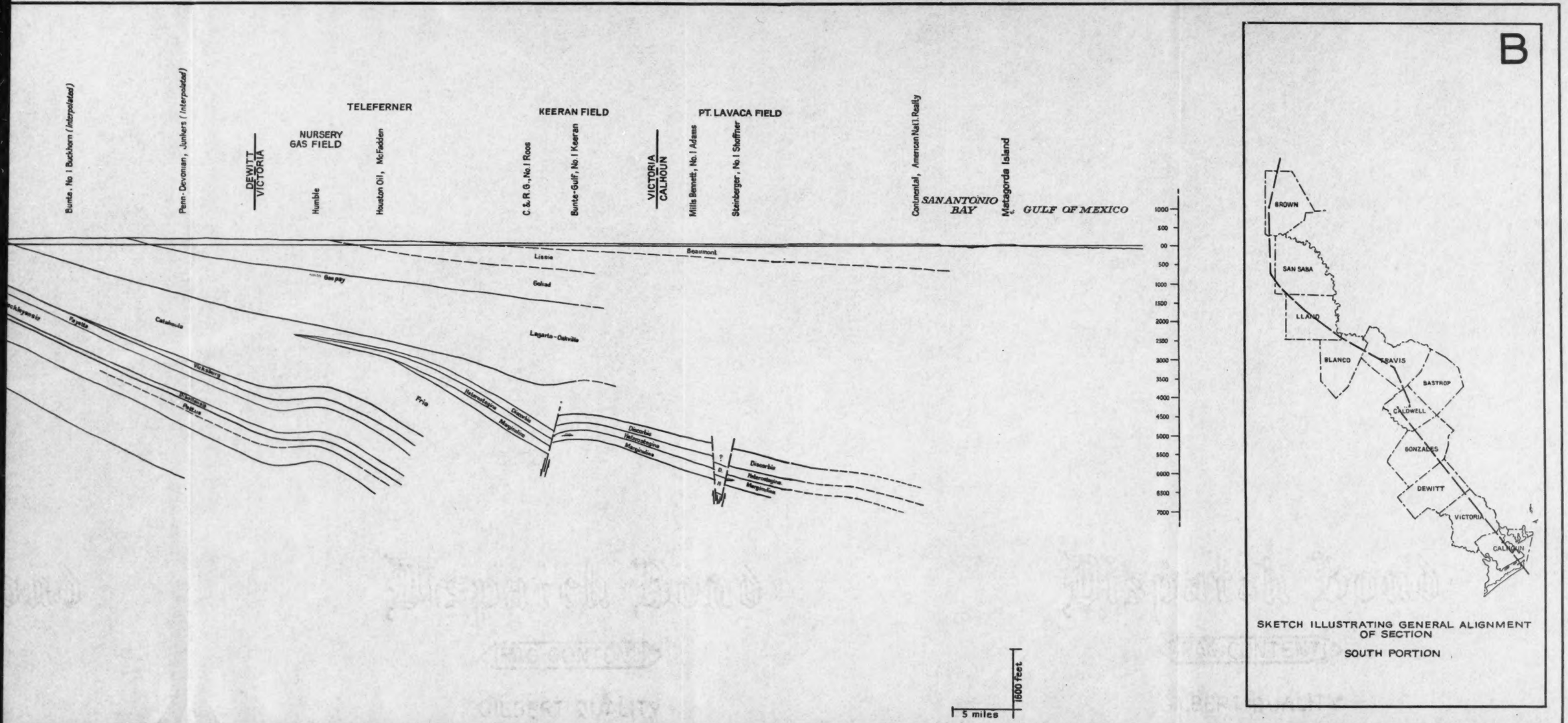
Igneous and Basement Rocks

Oil and Gas

1600 feet

5 miles


Colorado R.
AUSTIN
Pilot Knob
TRAVIS
CALDWELL
LYTTON SPRINGS
FIELD
SALT FLAT
CALDWELL
GONZALES
OTTINE FIELD
San Marcos R.
Ottine Field Type Log
Sou. Develop Co., No 1 Atkinson (Interpolated)
Luling O & G. No 1 Dubose (Interpolated)
GONZALES
DEWITT
Guadalupe R.
Bunte. No 1 Buckhorn (Interpolated)
Penn-Devonian, Junkers (Interpolated)
DEWITT
VICTORIA
TELEFERNER
NURSERY
GAS FIELD
Humble
Houston Oil. McFadden
KEERAN FIELD
C. & R. G., No 1 Roos
Bunte-Gulf, No 1 Keeran
VICTORIA
CALHOUN
Mills Bennett, No 1 Adams
Edwards
Comanchean
Alluvium and gravel
Black shale in wells
(Paleozoic)
Glen Rose
Trinity
Fault
SEA LEVEL
Wilcox
Midway
Navarro
Taylor
Austin
Eagleford
Buda
Edwards
Serpentine
Schist encountered in old Luling Field
Carrizo
Mount Selman
Cook Mountain
Yegua
Cockfieldensis
Yazoo
Catahoula
Vicksburg
Wilcox
Frio
Gas pay
Lissie
Goliad
Lagarto-Oakville
Heterostegina
Discorbis
Marginulina
Discorbis
Heterostegina
Marginulina
BALCONES
FAULT ZONE
1600 feet
5 miles



SKETCH ILLUSTRATING GENERAL ALIGNMENT OF SECTION

SOUTH PORTION

dome, and also the thinning in opposite directions of the Pecan Gap and Austin chalks.

Section *B* is, in general, at right angles to section *A*, extending from the Coast at Port Lavaca northwestward to the Central Mineral region, thence north along the Bend arch across Red River at Burkburnett, and thence to the Denver Producing Company's deep test in Caddo County, Oklahoma. From the Coast to the Salt Flat oil field in Caldwell County, this section follows a broad structural feature, commonly called the "San Marcos arch." Beneath this arch, basement rocks are thought to be nearer the surface than they are northeast and southwest of it, in the salt-dome basins of the interior, Gulf Coast, and Rio Grande embayment. No salt has been found in this area and the structures are somewhat different from those overlying salt plugs in the salt-dome basins. Most of the fields in the coastal belt are elongate along the regional strike and are closely associated with normal faulting. Several types of production are illustrated in the Balcones region, including normal faulting of the Mexia-Powell type, except that in this area, production comes from the Edwards limestone. Also, the igneous activity in this area has given rise to a unique type of accumulation, as shown by the fields around serpentine plugs. For the Balcones zone and the Central Mineral region, the Llano-Burnet and Austin folios of the United States Geological Survey were used and the information was generalized to some extent. An interesting feature of the region shown is the relative height of the Cretaceous beds around the sides of a topographically low area, occupied by the igneous and basement rocks of the uplift.

Northward, this section follows, in general, the axis of the Bend arch, along which oil and gas are found in the fields of north-central Texas. Ages of productive rocks are Ordovician and Pennsylvanian, production being from sand lenses and on terraces and noses. At Burkburnett, the Cisco sands are bowed into an anticlinal trap for oil by a range of buried granite hills which parallel the Arbuckle, Wichita-Amarillo uplift. This section is carried northward into Oklahoma, mainly for the purpose of showing correlations between the two states and the relationship of the Wichita Mountains and Central Mineral region to the Pennsylvanian basin between.

Section *C* was designed to show a "tie-in" between the fault zone fields of northeast Texas and the salt-dome area of the Gulf Coast. This section crosses successively younger formations as it approaches the Gulf of Mexico, and gives a very good idea of the position of certain oil-bearing formations from their outcrop, until they

have reached depths not yet reached by drilling. The area along the coast and immediately adjacent to it inland represents one of the deepest basins in this country, and is probably underlain by sedimentary rocks as deep as oil drilling will ever go. The relationship of the wedge of Oligocene sediments to beds above and below is shown, as well as other formations not present at the outcrop. Although the Conroe field is not shown, conditions similar to those in Conroe are illustrated by the Cleveland field. The Kittrell field represents a salt dome about midway between interior domes of the Tyler basin and the several types of the Gulf Coast. In the latter area, the deep nonpiercement type dome is illustrated by Esperson dome and a shallow piercement type with salt and cap-rock overhang is represented by Barbers Hill. This section passes through the North Dayton dome, but the latter feature was eliminated, since it would not show any particularly distinctive features and would tend to be confusing on a section of exaggerated scale. Productive horizons range from Lower Cretaceous to Pliocene and also cap-rock formations of the Coast.

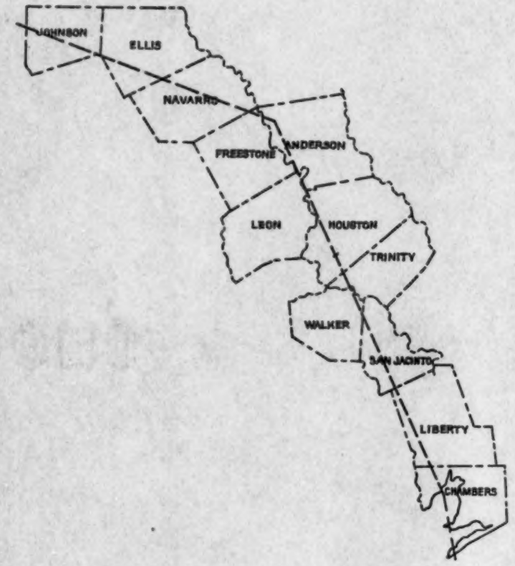
Section *D* does not show fully developed stages of some of the main features it traverses, since it crosses North Texas more or less along the axis of the Red River arch and its western extension. Throughout this area basement rocks are encountered at relatively shallow depths on certain structures. The part of the West Texas basin shown is relatively shallow, apparently influenced by the Amarillo uplift. It does, however, show something of the relationship between the West Texas area and the front range of the Rocky Mountains in New Mexico. A considerable part of this section is in New Mexico and shows the broad area of igneous rocks just east of the Sandia Mountains, which is covered by a veneer of Permian and Triassic sediments. Information on the western part of this section was taken from sections by N. H. Darton in *Bulletin 726* of the United States Geological Survey.

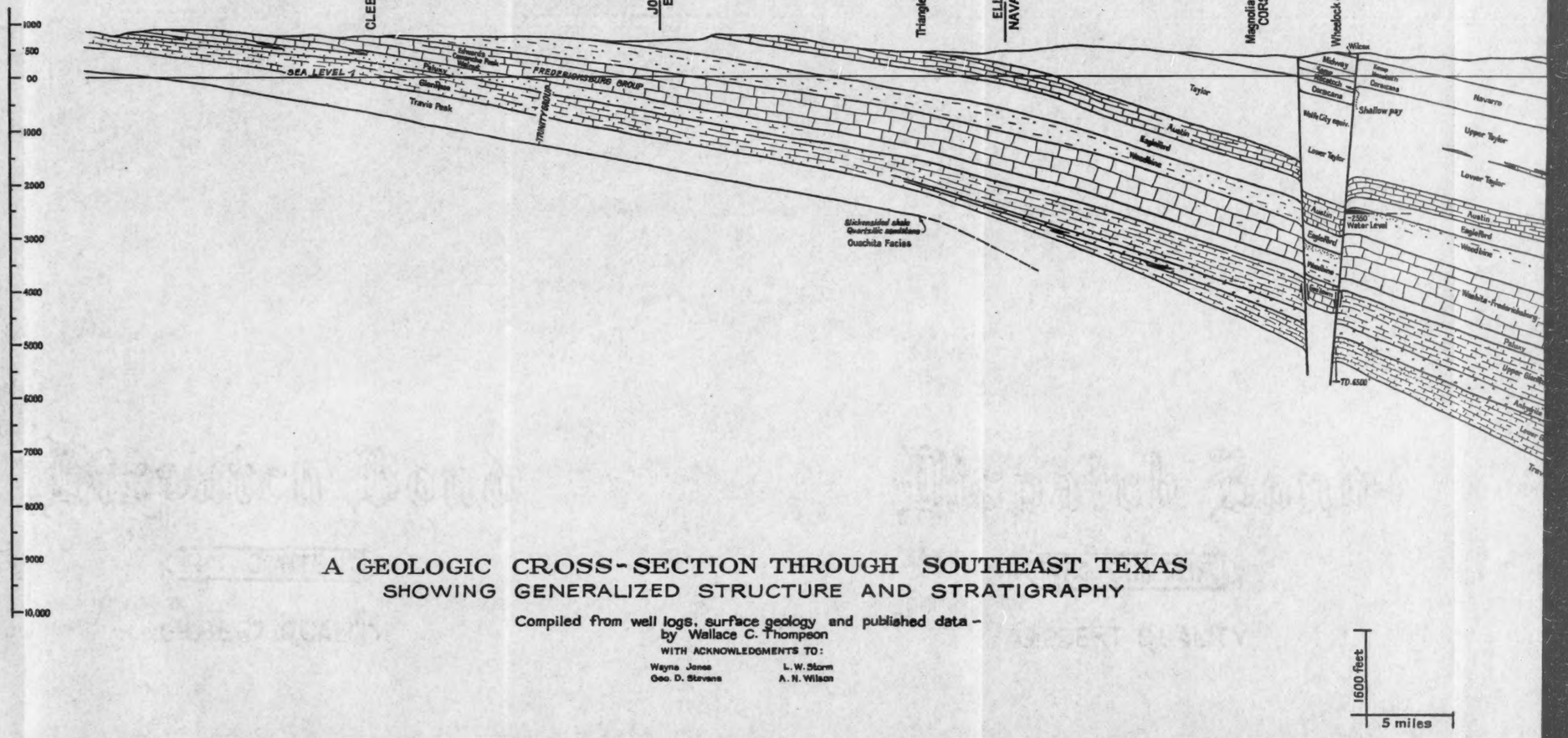
Section *E*, prepared by Willis Storm and Charles H. Row, shows the Rio Grande embayment and is interesting to compare with the salt-dome basin of southeast Texas and the section over the San Marcos arch. It is also significant to notice the tremendous thickening of the Lower Cretaceous toward Mexico.

Stratigraphic sequence from the Lower Cretaceous upward is generalized in this cross section for the principal purpose of explaining to the oil operators some of their problems, such as the approximate thickness of the formations and the geologic location of the various oil-producing horizons.

Abnormal structural features shown in the section include the

SKETCH ILLUSTRATING GENERAL ALIGNMENT OF SECTION





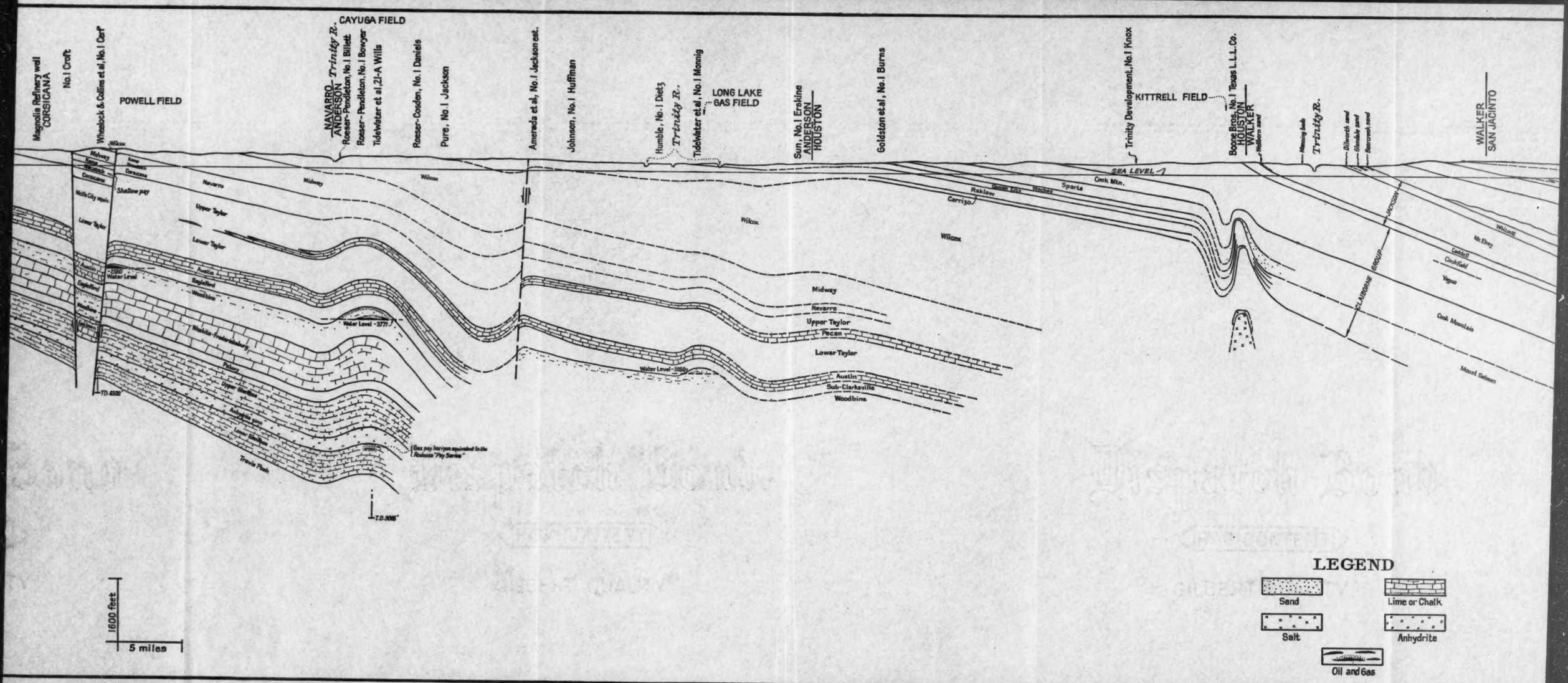
A GEOLOGIC CROSS-SECTION THROUGH SOUTHEAST TEXAS
SHOWING GENERALIZED STRUCTURE AND STRATIGRAPHY

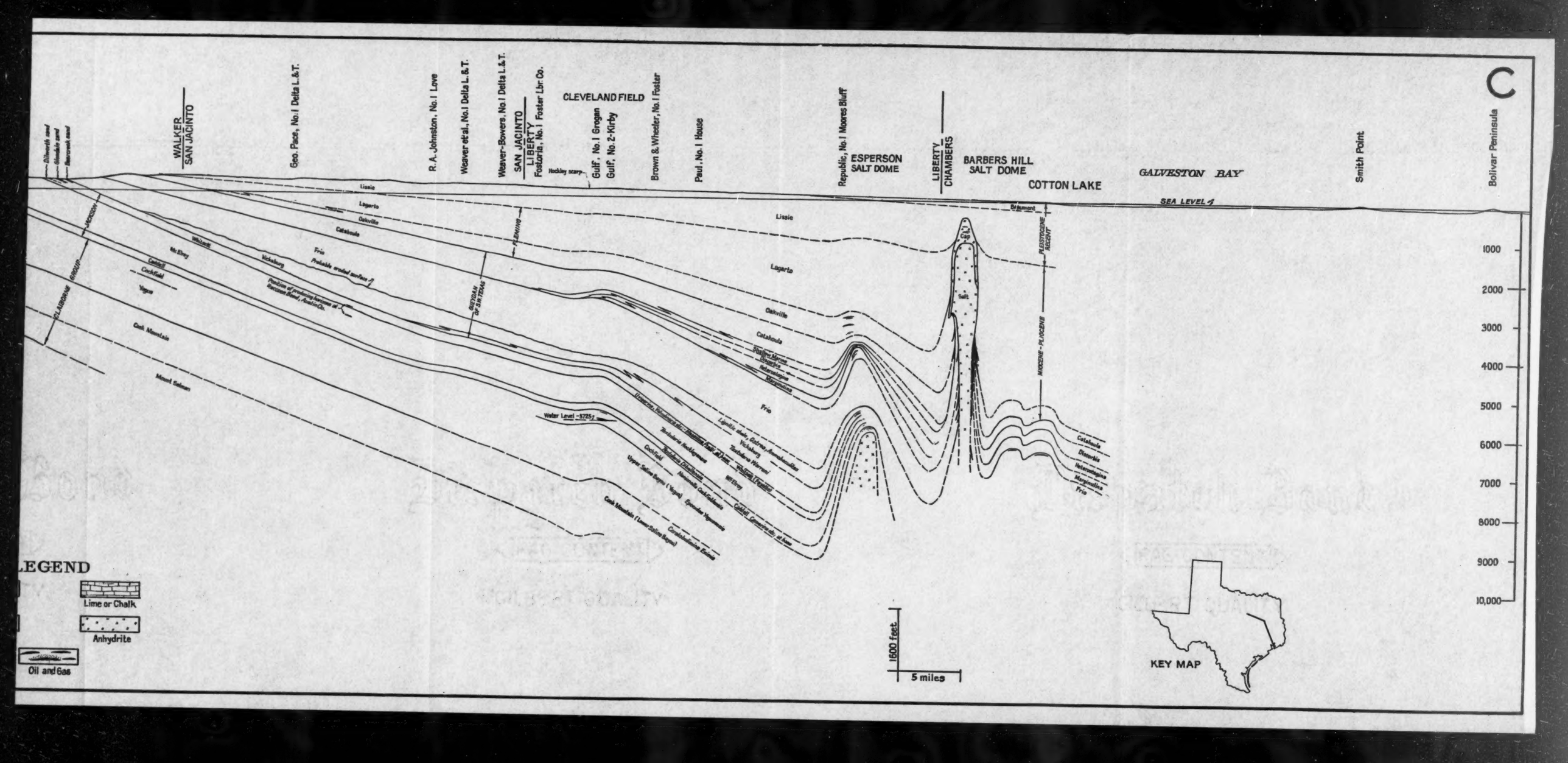
Compiled from well logs, surface geology and published data –
by Wallace C. Thompson

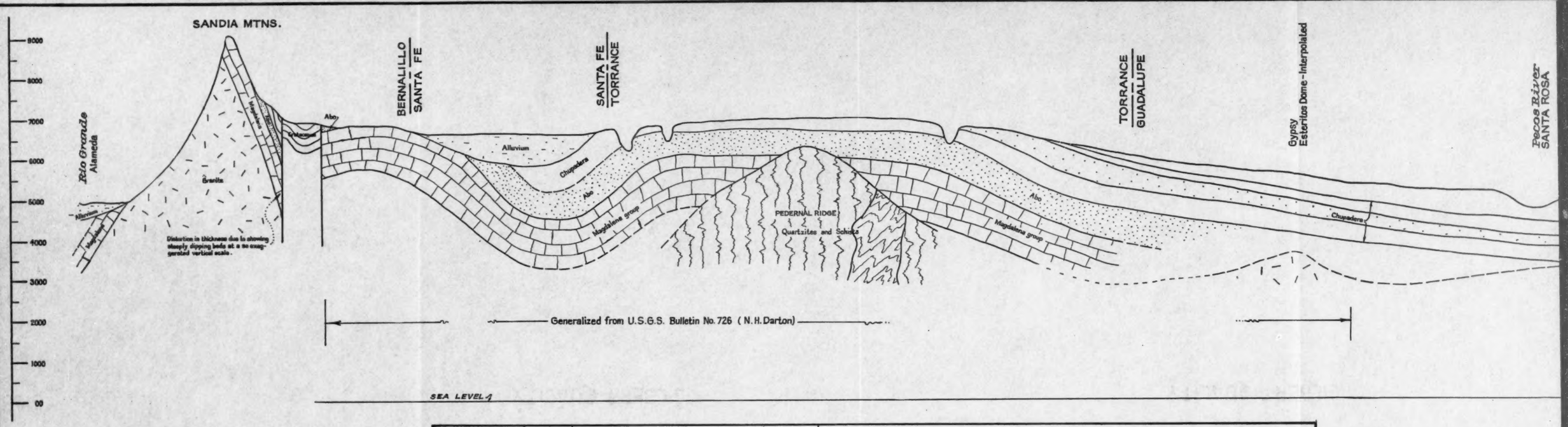
WITH ACKNOWLEDGMENTS TO:

Wayne Jones — L. W. Storm
Geo. D. Stevens — A. N. Wilson

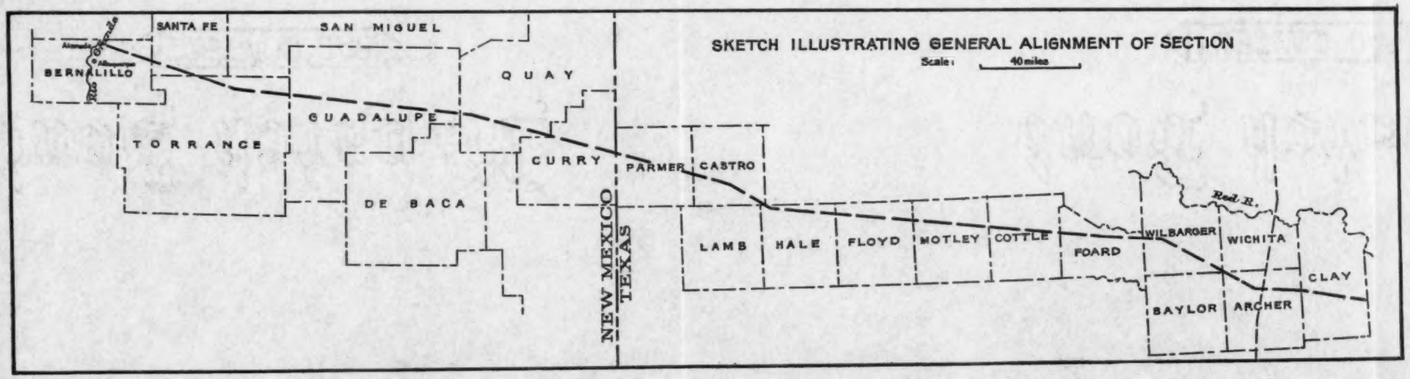
1600 feet
5 miles


Magnolia Refinery well CORSICANA
No. 1 Croft
Wheelock & Collins et al, No. 1 Corf
POWELL FIELD
CAYUGA FIELD
NAVARRO
ANDERSON
Trinity R.
Roeser-Pendleton, No. 1 Billett
Roeser-Pendleton, No. 1 Bowyer
Tidewater et al, 21-A Wills
Roeser-Cowden, No. 1 Daniels
Pure, No. 1 Jackson
Ameada et al, No. 1 Jackson est.
Johnson, No. 1 Huffman
Humble, No. 1 Dietz
Trinity R.
Tidewater et al, No. 1 Monnig
LONG LAKE GAS FIELD
Sun, No. 1 Erskine
ANDERSON
HOUSTON
Goldston et al, No. 1 Burns
Trinity Development, No. 1 Knox
KITTRELL FIELD
Boone Bros., No. 1 Texas L.L.L. Co.
HOUSTON
WALKER
Trinity R.
WALKER
SAN JACINTO
SEA LEVEL
Cook Mtn.
Sparta
Reklaw
Carrizo
Wilcox
Midway
Navarro
Upper Taylor
Pecan
Lower Taylor
Austin
Sub-Clarksville
Woodbine
CLAIBORNE GROUP
JACKSON
Weches
Mt. Elbert
Caddell
Cockfield
Yegua
Cook Mountain
Mount Selman
Water Level - 3777'
Water Level - 5050'
T.D. 6328'
T.D. 9095'
Gas pay horizon equivalent to the Robinson "Pay Series"
1600 feet
5 miles
LEGEND
Sand
Lime or Chalk
Salt
Anhydrite
Oil and Gas

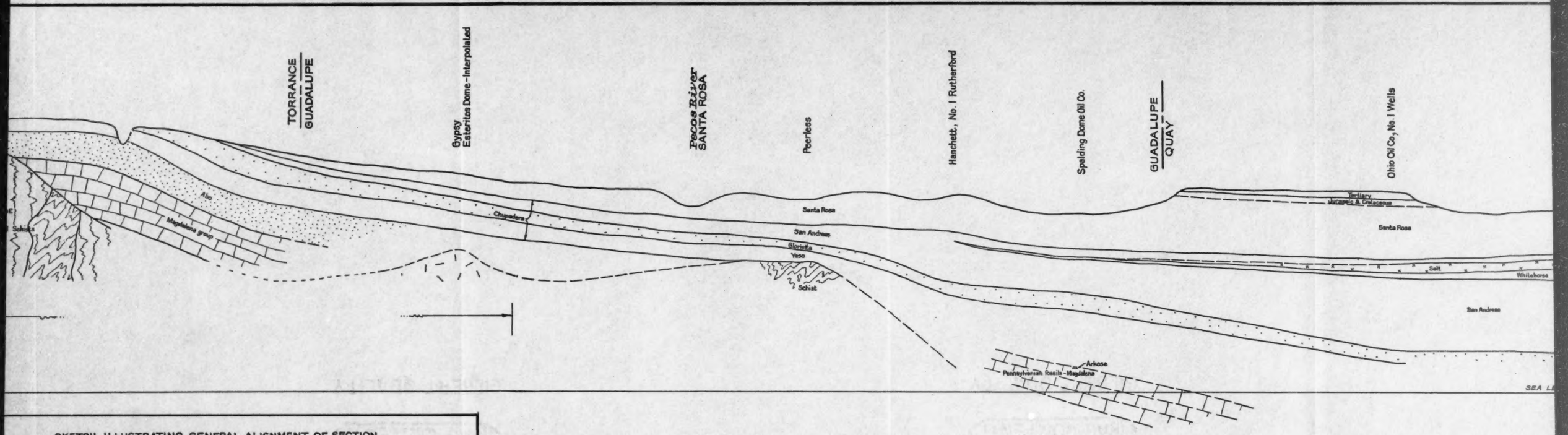

C
WALKER
SAN JACINTO
Geo. Pace, No.1 Delta L.&T.
R.A.Johnston, No.1 Love
Weaver et al., No.1 Delta L.&T.
Weaver-Bowers, No.1 Delta L.&T.
SAN JACINTO
LIBERTY
Fostoria, No.1 Foster Lbr.Co.
CLEVELAND FIELD
Gulf, No.1 Grogan
Gulf, No.2-Kirby
Brown & Wheeler, No.1 Foster
Paul, No.1 House
Republic, No.1 Moores Bluff
ESPERSON
SALT DOME
LIBERTY
CHAMBERS
BARBERS HILL
SALT DOME
COTTON LAKE
GALVESTON BAY
Smith Point
Bolivar Peninsula
SEA LEVEL
Lissie
Willis sand
Goliad sand
Beaumont
Lagarto
Oakville
Catahoula
Frio
Jackson
Vicksburg
Cockfield
Yegua
Cook Mountain
Mount Selman
Wilcox
Carrizo
Midway
Claiborne Group
Jackson
Fleming
Miocene
Oligocene
Eocene
Paleocene
Pleistocene
Recent
Miocene - Pliocene
Probable eroded surface
Position of producing horizons at Raccoon Bend, Austin Co.
Redoan or San Felipe
Water Level -3725'
Lignitic shale, Cockfield, Avondale sand
Vicksburg
Tuscahoma Hackberry
Tuscahoma Meridian
Tuscahoma Wilcox (Yegua)
Mt. Elbert
Mitchell Cockfield
Cockfield Conroe oil sand
Upper Yegua (Yegua) Eocene Vicksburg
Cook Mountain (Lower Yegua)
Cretaceous Eocene
Salt
Cap
Beaumont
Catahoula
Oakville
Fleming
Heterostegina
Marginulina
Frio
1000
2000
3000
4000
5000
6000
7000
8000
9000
10,000
1600 feet
5 miles
KEY MAP
LEGEND
Lime or Chalk
Anhydrite
Oil and Gas



KEY MAP

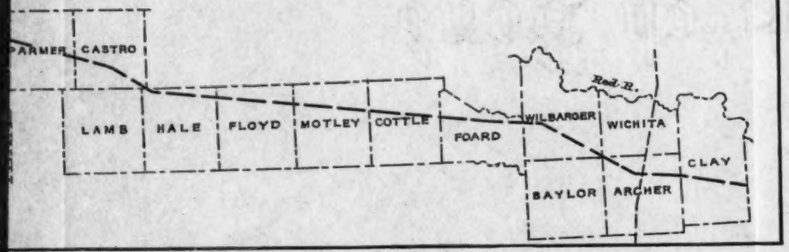


AGE
TRIAS
PERMIA
PENNSYLVA



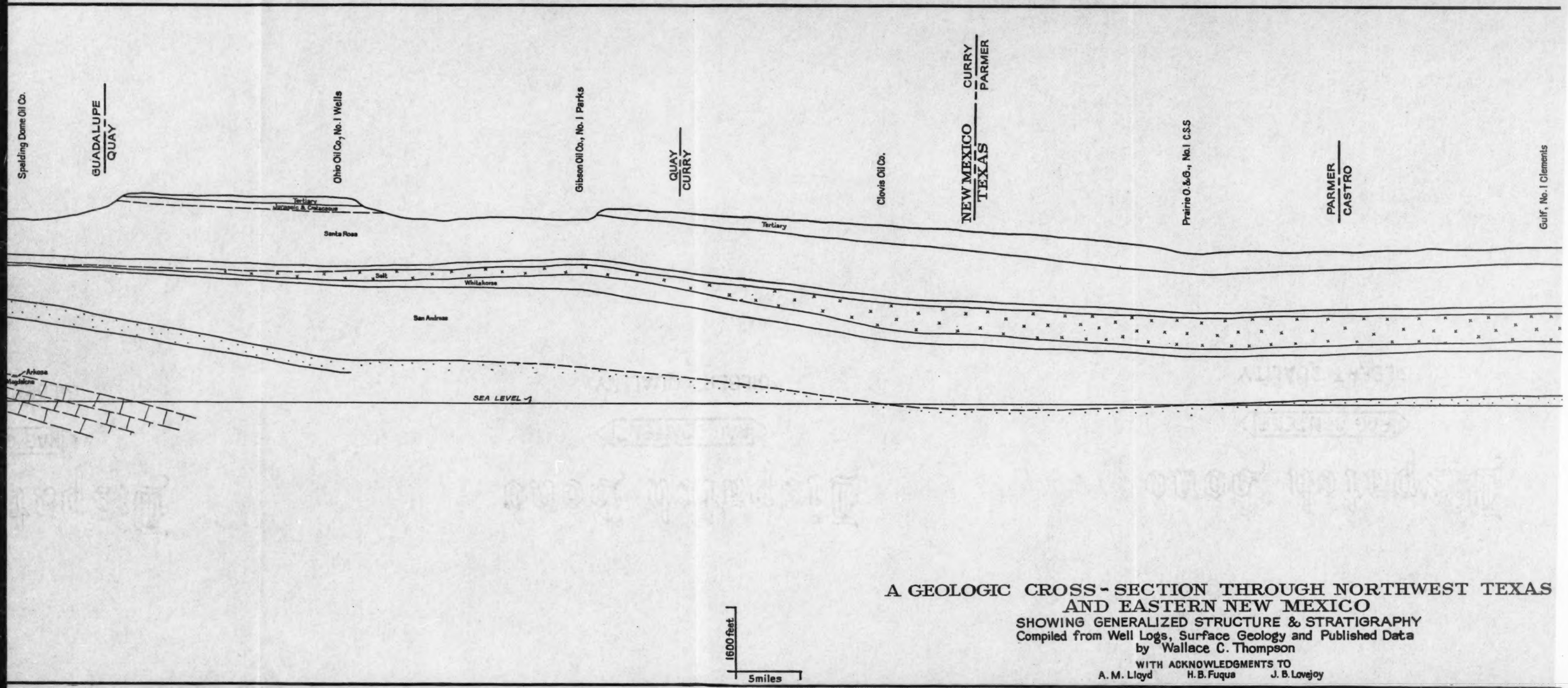
SKETCH ILLUSTRATING GENERAL ALIGNMENT OF SECTION

Scale: 40 miles



CORRELATION CHART

	NEW MEXICO		TEXAS
AGE	FORMATION		
TRIASSIC	Santa Rosa ss.		Dockum Beds
PERMIAN	CHUPADERA	San Andres	Quartermaster
			Cloud Chief
			White Horse
			Blaine
		Glorietta ss.	San Angelo
		Yeso	Clear Fork
		Abo ss.	Wichita-Albany
PENNSYLVANIAN	Magdalena		Cisco



A GEOLOGIC CROSS-SECTION THROUGH NORTHWEST TEXAS AND EASTERN NEW MEXICO

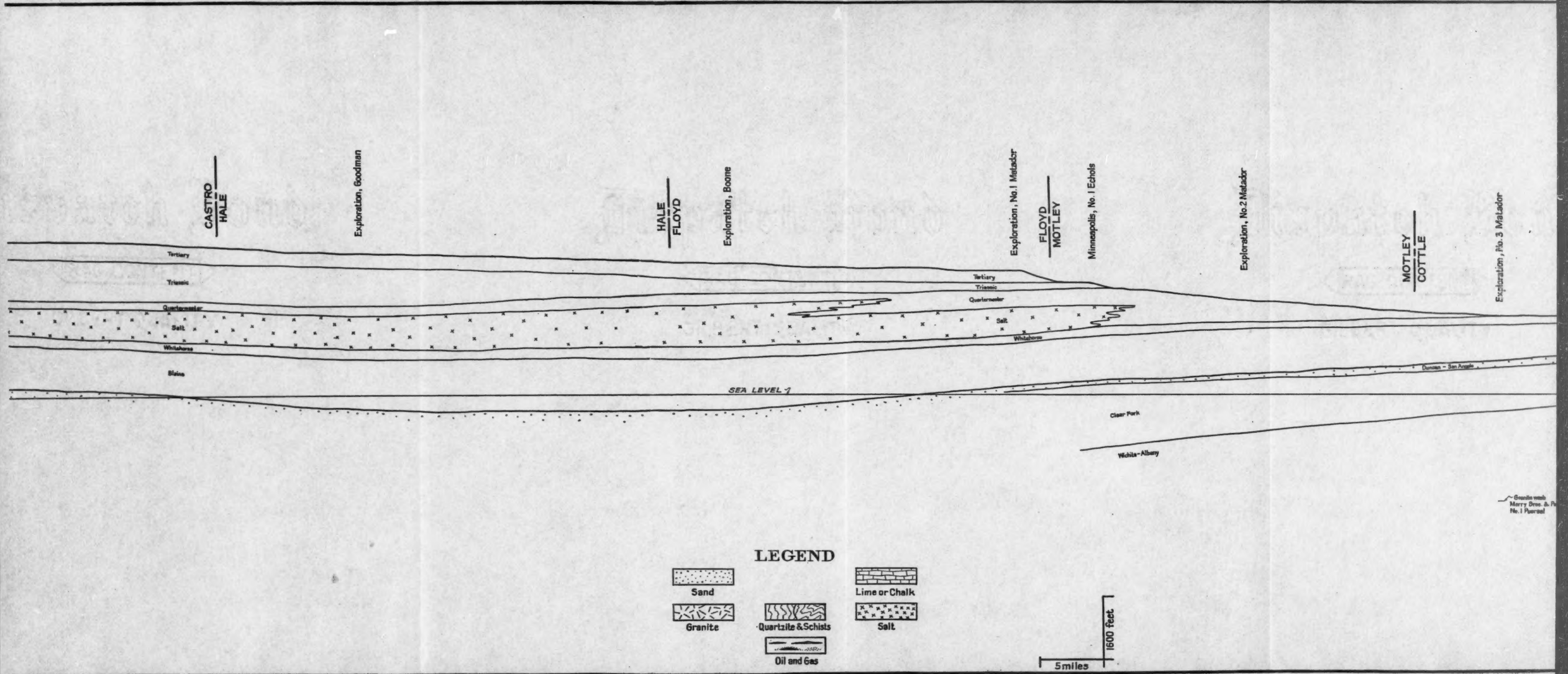
SHOWING GENERALIZED STRUCTURE & STRATIGRAPHY

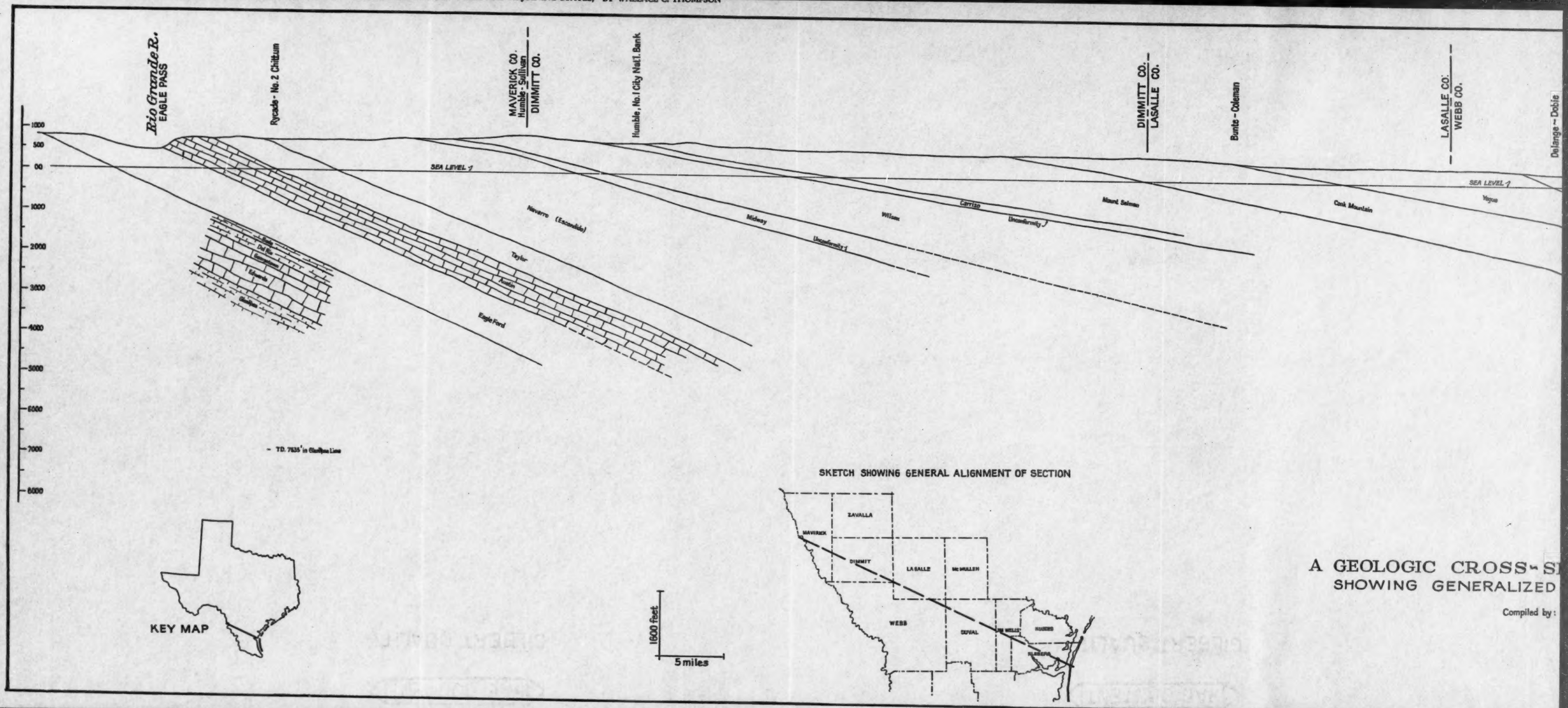
Compiled from Well Logs, Surface Geology and Published Data

by Wallace C. Thompson

WITH ACKNOWLEDGMENTS TO

A. M. Lloyd H. B. Fuqua J. B. Lovejoy


CASTRO
HALE
Exploration, Goodman
HALE
FLOYD
Exploration, Boone
Exploration, No.1 Matador
FLOYD
MOTLEY
Minneapolis, No.1 Echols
Exploration, No.2 Matador
MOTLEY
COTTLE
Exploration, No.3 Matador
Tertiary
Triassic
Quartermaster
Salt
Whitehorse
Blaine
SEA LEVEL
Clear Fork
Wichita-Albany
LEGEND
Sand
Granite
Quartzite & Schists
Oil and Gas
Lime or Chalk
Salt
5 miles
1600 feet



KEY MAP

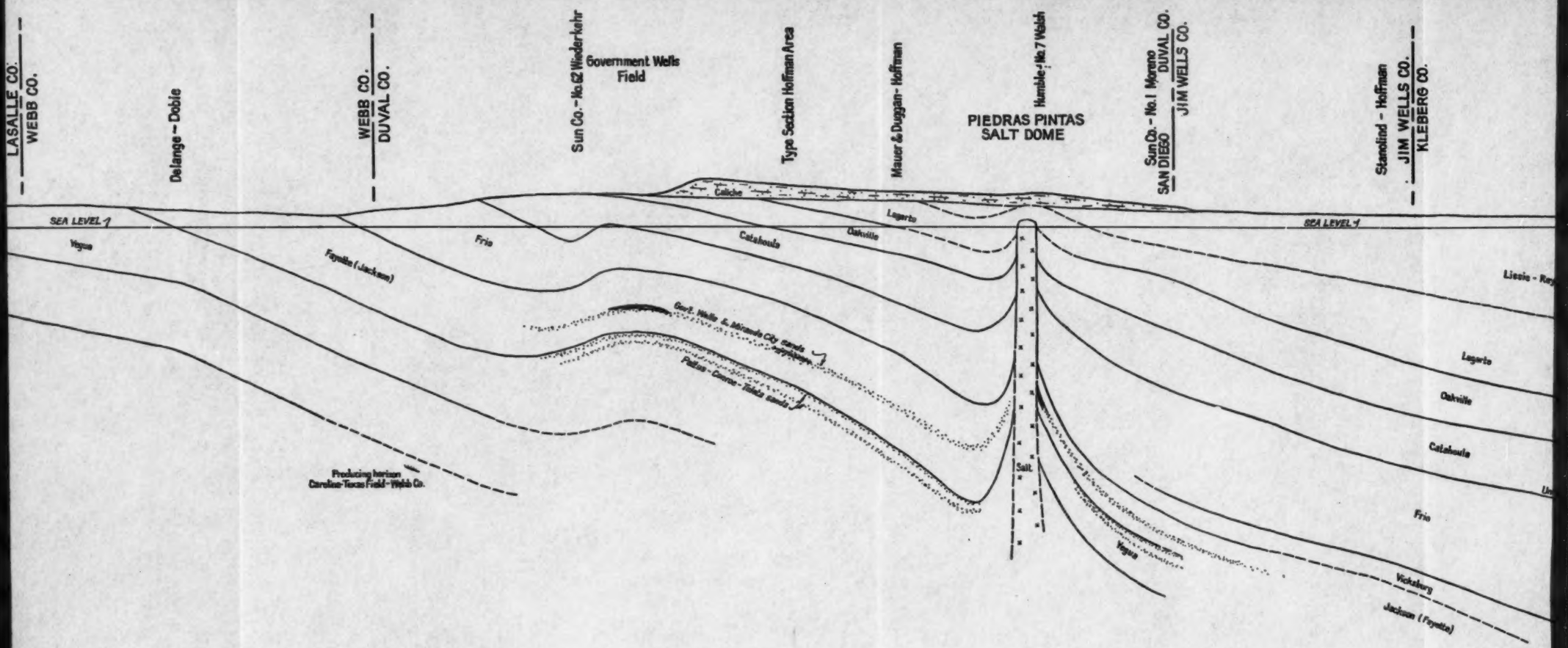
1600 feet

5 miles

SKETCH SHOWING GENERAL ALIGNMENT OF SECTION

A GEOLOGIC CROSS-S
SHOWING GENERALIZED

Compiled by:



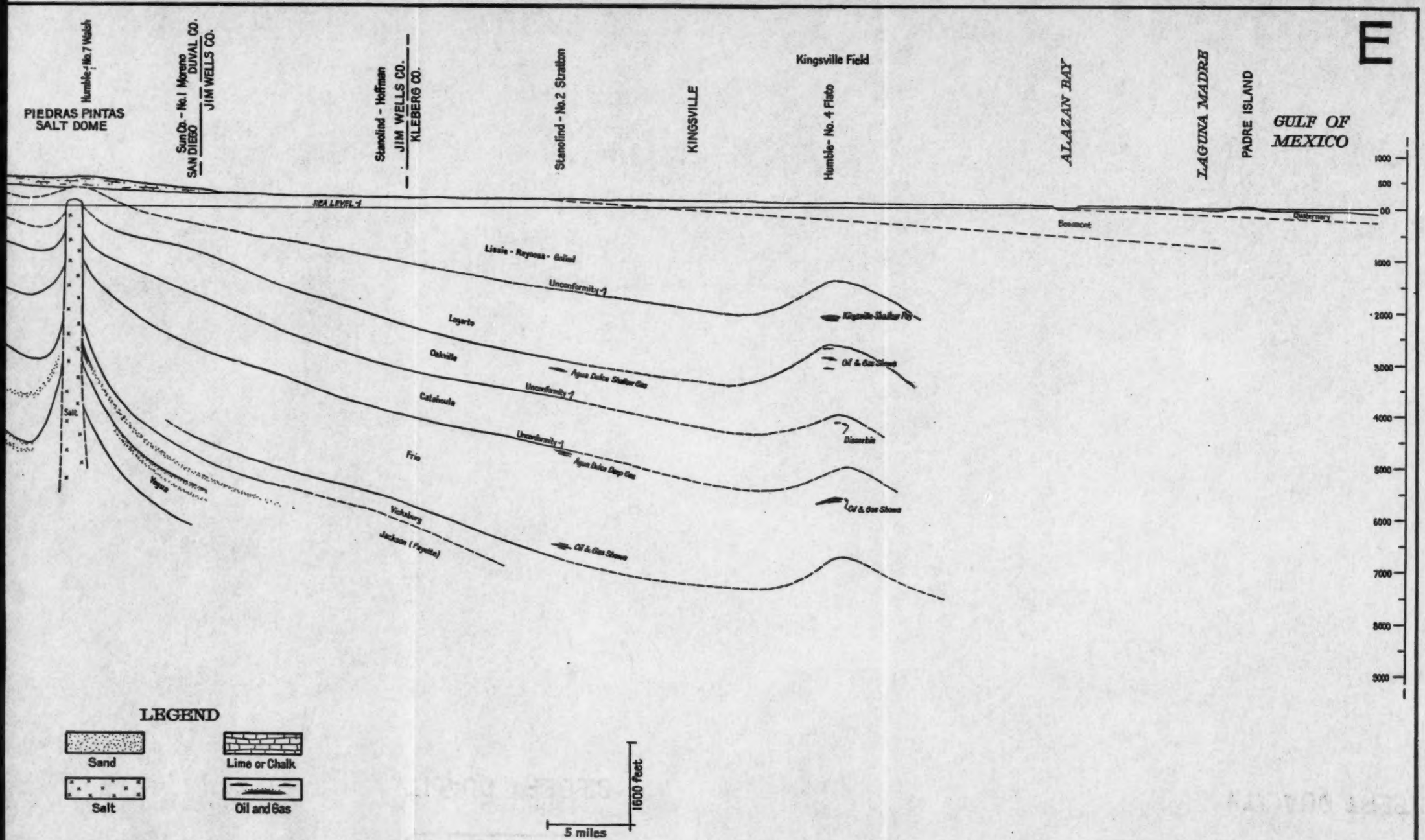
CROSS-SECTION THROUGH SOUTH TEXAS
GENERALIZED STRUCTURE AND STRATIGRAPHY

Compiled by: Willis Storm and Chas. H. Row

LEGEND

Sand
Lime or Chalk
Salt
Oil and Gas

A. N. Wilson — 1-'35


E
PIEDRAS PINTAS SALT DOME
Humble - No.7 Welch
Sun Co. - No.1 Moreno
SAN DIEGO
DUVAL CO.
JIM WELLS CO.
Stanolind - Hoffman
JIM WELLS CO.
KLEBERG CO.
Stanolind - No.2 Stratton
KINGSVILLE
Kingsville Field
Humble - No. 4 Flato
ALAZAN BAY
LAGUNA MADRE
PADRE ISLAND
GULF OF MEXICO
SEA LEVEL
Basement
Quaternary
Lissie - Reynosa - Goliad
Unconformity
Lagarto
Oakville
Catahoula
Frio
Vicksburg
Jackson (Fayette)
Salt
Kingsville Shallow Fld
Oil & Gas Shows
Agua Dulce Shallow Gas
Agua Dulce Deep Gas
Discorbis
1000
500
00
1000
2000
3000
4000
5000
6000
7000
8000
9000
LEGEND
Sand
Lime or Chalk
Salt
Oil and Gas
1600 feet
5 miles

arching through Duval County, on which the various fields of western Duval County are located and the relative position of the shallow Palangana and Piedras Pintas salt domes, which are indicative of abnormal structural conditions in eastern Duval County.

It may be noted that the Oligocene sediments, which here include the Vicksburg, Frio, and Catahoula formations, as well as the Oakville and Lagarto formations of the Miocene-Pliocene, thicken considerably toward the Gulf. Little is known of the western and northwestern limits of the Vicksburg and Oligocene wedge. Present data indicate that the Jackson formation of Upper Eocene age is fairly uniform in thickness in the Gulf Coast region.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 21, NO. 8 (AUGUST, 1937), PP. 1088-1091

PROVED OIL RESERVES IN UNITED STATES OF AMERICA[1]

J. ELMER THOMAS[2]
Fort Worth, Texas

The proved reserves of crude petroleum in the United States as of January 1, 1937, were estimated[3] at 13,063,000,000 barrels of the standard 42 gallons. This is believed to have been a rather conservative estimate and the writer suggests a figure of 15,000,000,000 barrels for the fields now known.

The estimate was prepared by a committee of geologists, geophysicists, and petroleum engineers chosen by the American Petroleum Institute. Its members were selected to give representation to those best acquainted with all of the pools in the several petroliferous provinces in the various parts of the country. In assembling its figures the committee had access to the data and judgment of numerous men with specialized information on each particular area so that it may be said that more than 100 men participated in this compilation.

Two years ago a similar estimate of reserves was prepared[4] as of January 1, 1935, for the American Petroleum Institute by a committee composed of the past-presidents of the American Association of Petroleum Geologists whose findings were subsequently revised, particularly with respect to the very recent discoveries, by the same personnel preparing the 1937 estimate. The details of the two estimates by states are shown on the opposite page.

It should be emphasized that the figures tabulated here refer only to the oil reserves from known producing horizons in fields now developed and recoverable by operating methods now in use. They do not make allowance for any additional supply which may be obtained from known, comparable, untested structures in the vicinity of those now producing, or for other prospective productive horizons which

[1] Presented before the Seventeenth International Geological Congress, Moscow meeting, July, 1937. Manuscript received, July 1, 1937.

[2] Petroleum analyst.

[3] "Report of the Committee on Petroleum Reserves to the Board of Directors, American Petroleum Institute, March 15, 1937," *Amer. Petrol. Inst. Quarterly*, Vol. 7, No. 2 (April, 1937), p. 5.

[4] "Report of the American Petroleum Institute Special Committee on Production and Supply," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 20, No. 1 (January, 1936), pp. 1–14.

subsequently may be developed in fields now producing, or for enlarged ultimate yields which may be recovered by improved operating methods, or for the vast supply of petroleum and its products definitely available in the enormous oil-shale deposits, or for the petroleum products which will one day be obtained by the hydrogenation of coal.

State	*Jan. 1, 1935 (Revised)* (*Figures in millions of barrels*)	*Jan. 1, 1937*
Western		
California	3,261	2,956
Rocky Mountain		
Colorado	16	15
Montana	102	92
Wyoming	267	239
Central-Southwestern		
Arkansas	103	84
Kansas	390	568
Louisiana	513	524
New Mexico	451	471
Oklahoma	1,235	1,141
Texas	6,643	6,422
Eastern		
Illinois	37	28
Indiana	5	3
Kentucky	50	39
Michigan	64	44
New York	75	66
Ohio	40	32
Pennsylvania	340	307
West Virginia	40	32
Total—United States	13,632	13,063

The Bilibin method[5] seems to afford a convenient classification for data bearing upon the complex problem of estimating future oil reserves. It is the practice of American engineers engaged in this work to apply those same considerations to the data so far as the producing and proved (by completed wells) areas are concerned. As to the untested potentialities of probable and possible areas, even with any well considered arbitrary, mechanical, or mathematical measuring stick, the human element nevertheless would introduce such variable factors that a ready comparison between districts, between states, or between countries would be somewhat questionable. Possibly if some group of men equally well informed about the geology, geophysics, and petroleum engineering in all areas of all countries were able to devote their time to the problem of estimating the petroleum reserves of the world, comparable results for the various nations might be obtained. But, perhaps there is no such group of men.

[5] V. V. Bilibin, "Method of Estimating Underground Oil Reserves," *Problems of Soviet Geology*, Vol. 6, No. 1 (January), pp. 34–42; Vol. 6, No. 2 (February, 1936), pp. 123–36. In Russian.

Supply *per se* is not a finite quantity; supply-at-a-price is the consequential term and the supply which would be secured at any given price range will differ from that at any other price levels. To carry far into the future—and much of these reserves will only be recovered many years from now—speculation as to future petroleum prices would also involve speculation as to future material prices, labor costs, and such other intangibles as future technical improvements. The writer believes that no useful purpose would be served by such studies at this time.

If we were also to give consideration to known favorable structures as yet untested, or to potentially productive territory not yet examined, or to deal with probabilities and possibilities in an attempt to evaluate such prospects in terms of barrels, together with the definite reserves-at-a-price contained in oil shales and coal deposits, a figure for total future supply would result several times the 13 billion-barrel estimate here cited for the United States.

For more than 50 years the pastime of indulging in such estimates has been followed by various groups or individuals in the United States more or less qualified to discuss the subject. The earliest estimates were notably understatements; in fact, it frequently occurred that a new estimate would note that all the reserves postulated in earlier estimates already had been recovered. This has not been true since 1925, when the American Petroleum Institute's Committee on Supply made their report.

Of course the earlier estimates of necessity were based on meager data, with depths of drilling now attainable then unknown, and with certain important petroliferous provinces then untested. It follows naturally that subsequent estimates, predicated on more and better data, have reached closer approximations of the then known reserves. And yet it follows logically that these later and better estimates eventually will be found to be too low. An engineer inevitably deals with what he knows and sees and not with what he thinks and believes. The writer hazards the opinion that each member of the committee which prepared the latest estimate here cited feels privately that its total will be doubled, and perhaps a higher multiple will be realized.

A word on future discoveries in the United States may conclude this statement. Past discoveries have been ably analyzed by Wallace E. Pratt[6] who finds that our rate of oil-finding between 1900 and 1930 was uniformly accelerated coincident with the expanding use of

[6] Wallace E. Pratt, "Discovery Rates of Oil-Finding," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 21, No. 6 (June, 1937), pp. 697–705.

automobiles and their requirements for motor fuels. Though geological exploration was responsible for most discoveries, that has passed its peak and since 1930 geophysics has been in the ascendancy; but as its current finding rate seems insufficient to increase or maintain known reserves, greater attention soon will have to be given to an intensive search for "stratigraphic traps," a more difficult and expensive type of exploration.

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THE ASSOCIATION ROUND TABLE

MEMBERSHIP APPLICATIONS APPROVED FOR PUBLICATION

The executive committee has approved for publication the names of the following candidates for membership in the Association. This does not constitute an election, but places the names before the membership at large. If any member has information bearing on the qualifications of these nominees, he should send it promptly to the Executive Committee, Box 1852, Tulsa, Oklahoma. (Names of sponsors are placed beneath the name of each nominee.)

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Maryld Charles Roberts, Oklahoma City, Okla.
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MID-YEAR MEETING, PITTSBURGH, OCTOBER 14–16, 1937

Members and guests attending the fall meeting of the American Association of Petroleum Geologists to be held at Pittsburgh, Pennsylvania, October 14, 15, and 16, 1937, will be offered a varied program of field trips planned to cover briefly but effectively three major fields of interest. These are: (1) the structure of the Appalachian province from the Ohio River eastward to the Blue Ridge Mountains and the stratigraphy of the Appalachian province from Cambro-Ordovician limestones at the base of the column to Permian shales at the top; (2) the history of the development of the oil industry in the land of its nativity; (3) the part the oil industry has played in the development of the giant which is Steel.

Contrary to the custom at A.A.P.G. meetings, the opening field trip is to be a pre-convention trip. This arrangement will enable those coming from west of the Mississippi River to utilize a week-end for traveling to Pittsburgh and will thereby save them at least two days in total time away from their offices. This arrangement will also save overlapping in trips and therefore

throw all trips open to the entire attendance at the meeting. It is believed, also, that the papers to be presented at the technical sessions can be made of more value to those attending if field contact is had with the regional geology prior to technical discussion.

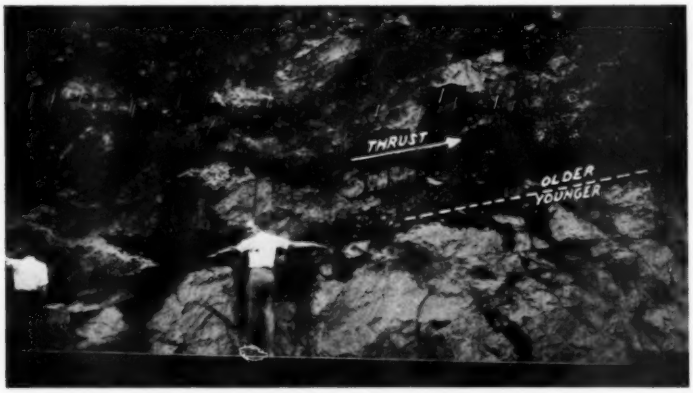

FIG. 1.—Overthrust fault near Birmingham, Pennsylvania. Warrior limestone (Cambrian) thrust over Carlim limestone (Lower Ordovician). Throw, 5,000 or 6,000 feet.

FIG. 2.—Syncline in Wills Creek formation (Upper Silurian) near Hancock, Maryland.

The first trip is planned to consume three days and will leave from the William Penn Hotel in Pittsburgh, Monday morning, October 11. Pennsylvania State Highway No. 88 will be followed up the valley of the Monongahela

River to Brownsville, Pennsylvania, where the party will turn southeastward on U. S. Highway No. 40, the historic Old National Trail, to Keyser, Maryland. At this point the trip will drop southward on U. S. Highway No. 219 to Redhouse, Maryland, the first day's luncheon stop. In the afternoon the Appalachian Mountains will be traversed eastward to Winchester, Virginia, and the party will travel thence down the Shenandoah Valley on U. S. Highway No. 11 to New Market, Virginia, for the night stop. An evening trip through Endless Caverns has been arranged for this first evening.

On Tuesday morning, October 12, the trip will continue southwestward down the Shenandoah Valley on U. S. Highway No. 11 to Lexington, Virginia, where it will turn westward on U. S. Highway No. 60 recrossing the Appallachian Mountains to the second night's stop at Charleston, West Virginia. The evening meal and a subsequent program here is in charge of the Appalachian Geological Society.

On the third day the party will be routed to Parkersburg, West Virginia, on U. S. Highway No. 21, thence to Wheeling, West Virginia, on West Virginia State Highway No. 2, thence to Washington, Pennsylvania, on U. S. Highway No. 40, and into Pittsburgh on U. S. Highway No. 19. The trip on this day will traverse the oil and gas fields of the Southern Appalachian region and opportunity will be afforded to see such structural features as are apparent in surface rocks.

This initial trip of the 1937 fall meeting traverses one of the outstanding scenic areas of the North American Continent. Geologically, it is the land of our heritage. In these Appalachian Mountains the science of geology in North America took its first toddling steps and this still remains the classic area of petroleum geology. Although, to the casual observer the Appalachian province may appear to present a relatively simple regional picture, a closer inspection will reveal its highly complex character. A wealth of striking exposures coupled with the unique physiography of the region have made this one of the most intriguing areas for geologic field studies in the world.

During the three days of the meeting in Pittsburgh it is planned to hold technical sessions on one-half of each day only. The other half of each day has been left free for trips to points of interest in and adjacent to the city. A trip will be offered to one of the modern rolling mills where the manufacture of pipe for oil field use can be studied at close range. A visit to the Carnegie Museum has been arranged which will afford opportunity for close inspection of one of the world's outstanding exhibits in the field of vertebrate paleontology as well as the inspection of an interesting collection of mineral specimens including precious and semi-precious stones. A trip through the most completely mechanized coal mine in the world will be offered if there is demand for it, as will be trips through the laboratories of the Westinghouse Electric and Manufacturing Company and several of the plants in the Pittsburgh district engaged in the manufacture of special equipment for use in the oil industry. A short trip has been planned to cover the stratigraphy, structure, and physiography of the very interesting region around the confluence of the Monongahela and Allegheny rivers which combine their waters in the heart of downtown Pittsburgh to form the mighty Ohio.

On Saturday afternoon, October 16, immediately following the Carnegie Tech-Notre Dame football game, a post-convention trip will leave Pittsburgh and, traveling through the Northern Appalachian fields, will stop for the

night at Franklin, Pennsylvania. On Sunday, Oil City and Titusville, Pennsylvania, the Drake well, and the Bradford field will be visited. Arrangements are under way to visit on this day repressuring operations in the Titusville area and water-flooding operations in the Bradford field.

Those taking this last trip may leave for their homes on Sunday night, October 17, from Bradford, Pennsylvania, or Buffalo, New York, or may return to Pittsburgh for later departure.

THE WORK OF THE LOCAL COMMITTEE WOULD BE MATERIALLY FACILITATED IF THOSE WHO PLAN TO MAKE THE PRE-CONVENTION FIELD TRIP WOULD SIGNIFY THEIR INTENTION BY A LETTER OR POST CARD ADDRESSED TO M. G. GULLEY, BOX 1166, PITTSBURGH, PENNSYLVANIA, AS SOON AS POSSIBLE. IT IS ESTIMATED THAT THE ENTIRE EXPENSE OF THIS TRIP WILL BE APPROXIMATELY $20.00 FOR THE THREE DAYS.

M. GORDON GULLEY.

Cathedral of Learning, Pittsburgh

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AT HOME AND ABROAD

CURRENT NEWS AND PERSONAL ITEMS OF THE PROFESSION

HUBERT G. SCHENCK, of Stanford University, California, is in Iran as field paleontologist for the Amiranian Oil Company.

LINN M. FARISH, of the Amiranian Oil Company, 39 Broadway, New York City, is attending the 17th International Geological Congress at Moscow, as one of the A.A.P.G. delegates. His itinerary includes the petroleum excursion into the Baku area and later Persia and Afghanistan for a trip over his company's concessions.

HANS JILOVKSY received the M.E. degree from the Montanistische Hochschule, Leoben, Styria, Austria, in 1934, studied geology and geophysics at the Colorado School of Mines in 1935 and 1936, and is now employed in the production department of the Carter Oil Company, Tulsa, in the Kansas district.

The 23d annual meeting of The American Association of Petroleum Geologists will be held at the Roosevelt Hotel, New Orleans, Louisiana, March 16–18, 1938. R. A. STEINMAYER, of the geological department of Tulane University, is general chairman of the committees on arrangements.

BENJAMIN T. SIMMONS, who received his M.S. degree in geology at Rochester University, Rochester, New York, and was recently in Texas with a field party of the Seismograph Service Corporation of Tulsa, Oklahoma, is junior geologist with the Standard Oil Company of Venezuela stationed at Quiriquire, Venezuela.

MARION H. FUNK, geologist with the Sun Oil Company for several years at McAllen, Texas, is stationed at Tallahassee, Florida. His postoffice box is 795.

J. D. WATSON, recently in charge of geological work for the Turman Oil Company, has opened a consulting office at 1610 South Norfolk, Tulsa, Oklahoma.

JOSEPH A. CUSHMAN, Sharon, Massachusetts, received an honorary degree of Doctor of Science from Harvard University at its commencement on June 24. President Conant conferred the degree with the following citation: "A pioneer biologist whose microscope explores the geologic ages, a guide to men who pierce the earth in search of liquid treasure."

HENRY V. HOWE, head of the geology department of Louisiana State University, Baton Rouge, has been appointed one of the five members of the nonpartisan State Mineral Board. Governor Richard W. Leche is chairman of this new board which has authority to lease State lands for development.

SYLVAIN PIRSON, head of the department of petroleum and natural gas engineering, Pennsylvania State College, is doing geophysical work in the

Mid-Continent region during July and August for the Seismograph Service Corporation of Tulsa, Oklahoma.

IRA A. DUGAN, formerly deputy proration umpire in the Fitts pool, Oklahoma, has opened a consulting office in Ada, Oklahoma, and will specialize in geological, valuation, and proration work, in addition to petroleum engineering.

W. C. IMBT, geologist for the Stanolind Oil and Gas Company, has been transferred from Midland, Texas, to Mattoon, Illinois.

R. L. MARSTON, production superintendent for the Sun Oil Company in the Rio Grande City district, Texas, has been temporarily transferred to Aberdeen, Washington, to supervise the drilling of a deep wildcat near Forks, Washington.

FLOYD M. AYERS, geologist for Gulf Oil Corporation in West Texas, with headquarters at Midland, has resigned to accept foreign service with Nederlandsche Koloniale Petroleum Maatschappij in Sumatra and New Guinea.

LOUIE C. KIRBY, formerly with Ultramar S.A.P.A., Lumbreras (FCCNA), Prov. de Salta, Argentina, has returned to the United States and may be addressed at Gentry, Arkansas.

J. C. FINLEY, formerly geologist with the Phillips Petroleum Company, Bartlesville, resigned July 1 to become chief geologist with the Turman Oil Company, Tulsa, Oklahoma. His address is 518 National Bank of Tulsa Building.

HENRY CARTER REA, formerly with the Shell Petroleum Corporation, Tulsa, sailed from New York City on August 3 to do reconnaissance work in Afghanistan for the Inland Exploration Company, 39 Broadway, New York City.

THOMAS J. ETHERINGTON, formerly of Plaquemine, Louisiana, is now with the Richmond Petroleum Company, Apartado Nacional 3, Ibague, Colombia, S. A.

NATHAN C. DAVIES is associated with the Standard Oil Company of California, and may be addressed at Box 1200, Bakersfield, California.

GEORGE W. LAPEIRE, formerly chief geologist for the United Fuel Gas Company, Charleston, West Virginia, has established consulting geological offices at Robinson, Illinois. He may be addressed at postoffice box 28.

JOSEPH NEELY, formerly in the department of geology, University of Wyoming, Laramie, is now with the Magnolia Petroleum Company at Oklahoma City, Oklahoma.

W. KEITH MILLER, formerly located at Coldwater, Kansas, is now at Henderson, Kentucky, and may be addressed at 710 North Main Street.

W. H. MADDOX, formerly with the Richmond Petroleum Company of Mexico, stationed at Mexico City, has been transferred to N. V. Neder-

landsche Nieuw Guinee Pet. Mij., with headquarters at Babo, Netherlands New Guinea.

LUIS E. KEMNITZER is now geologist for The Petrol Corporation, 4020 Bandini Boulevard, Los Angeles, California, having completed his graduate studies at the California Institute of Technology, Pasadena.

E. G. DAHLGREN, recently named director of the conservation department, Kansas, was formerly chief clerk doing proration work for the Oklahoma Corporation Commission. He will reside in Wichita.

E. H. SELLARDS, director of the Bureau of Economic Geology at Austin, addressed the North Texas Geological Society, June 18, on "Some Chapters in the Geologic History of Texas."

W. G. ARGABRITE has joined the Island Exploration, Ltd., out of Melbourne, Australia.

C. F. HEWETT is chief geologist of the Superior Oil Corporation at Tulsa, Oklahoma. He was formerly with Standard Oil Company of New Jersey in Argentina.

FRANCES BEEDE, who received her M.A. degree at the University of Indiana, is employed in geological work for the Stanolind Oil and Gas Company at Tulsa.

DILLE and NUFER, consulting geologists, have moved to 808–809 Atlas Life Building, Tulsa, Oklahoma.

P. V. ROUNDY, geologist with the United States Geological Survey at Washington, D. C., died on June 21.

ANNA MINKOFSKY, graduate of Hunter College and Columbia University, received the A.M. degree in geology and petrology in 1937 and is now employed by the Shell Petroleum Corporation, Houston, Texas.

WALTER A. VER WIEBE is in Mexico during the summer. He may be addressed at the Hotel Ritz, 30 Madera, Mexico, D. F.

S. G. GARRETT, aged 44 years, geologist for the Superior Oil Company, died at La Jolla, California, July 8.

LAURENCE F. DAKE, of Rolla, Missouri, a geology graduate of the University of Wisconsin in 1937, is employed by the Shell Petroleum Corporation, Tulsa, Oklahoma.

N. H. DARTON has been spending July and August as guest at the Beartooth Research Camp near Red Lodge, Montana, to attend field conferences on the geology of the northern Rocky Mountain region and western North Dakota.

The Geological Map of Texas by N. H. DARTON, L. W. STEPHENSON, and JULIA GARDNER has been issued by the United States Geological Survey, scale 1:500,000, in 4 sheets. The topographic map of Texas by N. H. Darton is in second proof, scale, 1:500,000; contour interval, 100 and 200 feet with 50-foot contour added.

M. H. JAMESON, formerly of Golden, Colorado, is employed by the Seismograph Service Corporation, Tulsa, Oklahoma.

CARL C. ADDISON, geologist with the Pure Oil Company, has been transferred from Fort Worth, Texas, to Saginaw, Michigan, His address is 402 Second National Bank Building.

W. K. CLARK, formerly with the Shell Petroleum Corporation at Midland, Texas, is now with the Transwestern Oil Company, Corpus Christi.

GORDON W. HEID resigned his position with the Empire Oil and Refining Company, at Odessa, Texas, Ausust 1, to accept a position with the Shell Petroleum Corporation, Midland, Texas.

GEORGE P. HARDISON, geologist with the Shell Petroleum Corporation, has changed his address from Topeka, Kansas, to Box 497, Vincennes, Indidiana.

E. L. JOHNSON resigned his position with the Federal Royalties Company, Inc., Fort Worth, Texas, July 15, to accept a position with the Transwestern Oil Company, at Corpus Christi, Texas.

J. B. LEISER, Kansas regional geologist for the Shell Petroleum Corporation, who has been located at Tulsa, has gone to The Hague to spend a year working for the Royal Dutch Shell.

T. E. WALL, formerly in seismograph work, has organized the Wasweco Petroleum Company with offices in the Shell Building, Houston, Texas, and will engage in production in Mid-Continent and Gulf Coast fields.

GLENN D. HAWKINS, consulting geologist, Kennedy Building, is technical advisor, and JOHN W. MERRITT, consultant, 1324 East Seventeenth Place, is consulting geologist for the new monthly *Petroleum Royalties* which is being published in Tulsa under the editorship of ANDREW M. ROWLEY, formerly editor of the *Oil and Gas Journal*. The August issue of the new magazine contains the following geological contributions: "Future Possibilities in Illinois-Indiana," by W. V. HOWARD; "Grapeland-Slocum-Percilla District, Houston and Anderson Counties, Texas," by JAMES H. GARDNER; "Possibilities in Western Kansas," by ED BLOESCH; "The Billings Field in Oklahoma," by MALVIN G. HOFFMAN; "Rapid Development in Southwest Texas," by JOHN W. MERRITT and FRANK C. WIEST.

JOHN M. LOVEJOY, president of the Seaboard Oil Company, the Amiranian Oil Company, and the Inland Exploration Company, 39 Broadway, New York City, is in Europe during the summer.

VICTOR E. OPPENHEIM, consulting geologist for the Brazilian Government from 1933 to 1937, is now with the Caribbean Petroleum Company at Maracaibo, Venezuela.

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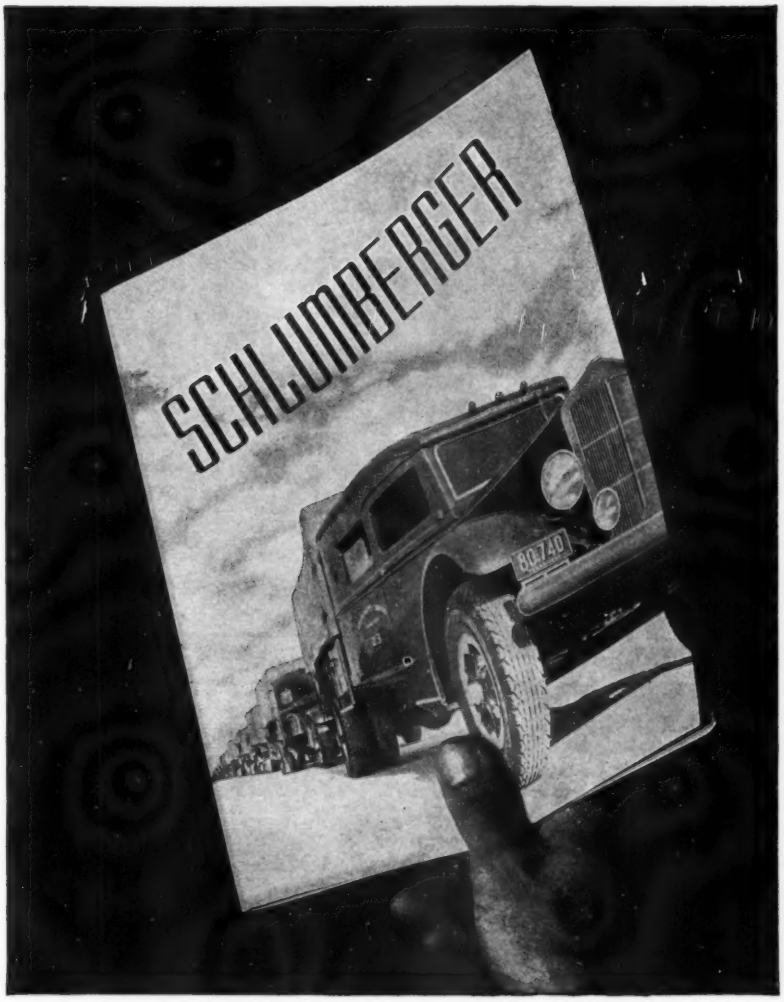

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OIL AND GAS GEOLOGY of the COASTAL PLAIN IN ARKANSAS

By W. C. SPOONER

With a chapter on UPPER CRETACEOUS OSTRACODA

By MERLE C. ISRAELSKY

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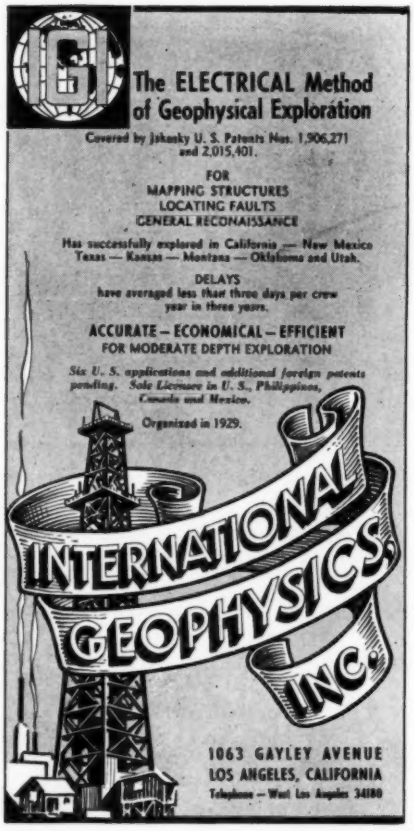

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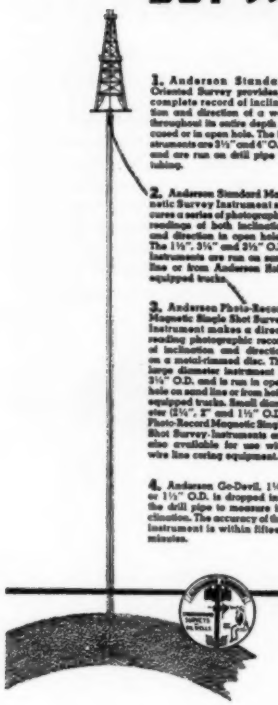

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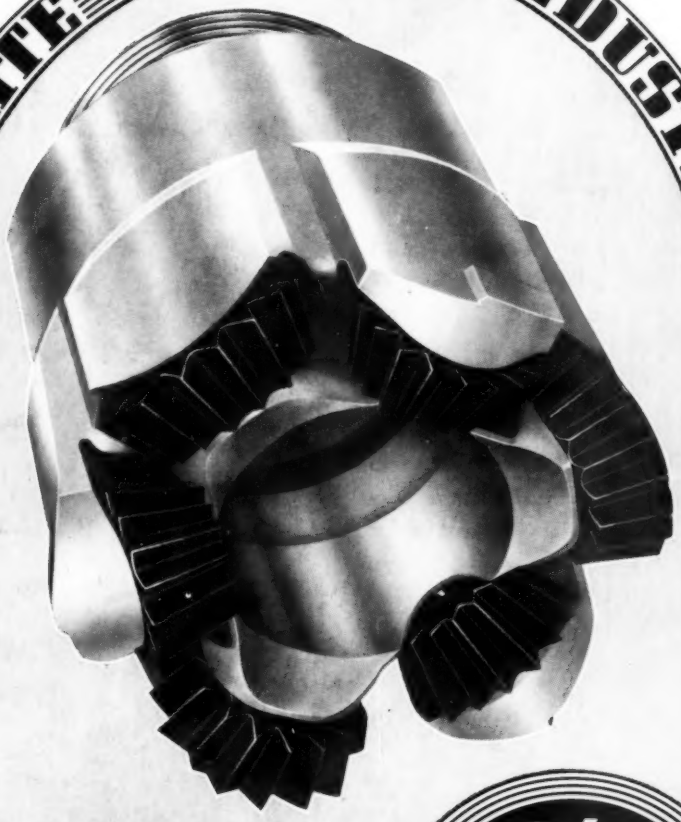

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